THE

ELECTRICAL REVIEW.

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"ELECTRICAL REVIEW."

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THE
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OUR LIMITS.

ELSEWHERE in this issue will be found the continuation of our abstract of the excellent address recently delivered before the Institution of Electrical Engineers by the President, Mr. James Swinburne. We would gladly have reproduced the text in full had it been possible; but our space, too, has its limits, and we were reluctantly compelled to abbreviate our report, handling the blue pencil, however, with care, so as to include, as far as possible, the essence of the lessons embodied in the address. No one doubted that the latter would be conspicuous for originality; the President, however, completely falsified the most intelligent anticipations of its nature and of the subjects with which he would deal, and, as he admits, denied himself the pleasure of adopting the *rôle* of optimist, in order to draw attention to the limitations which appear to bar the path of progress in various directions.

Before commencing a discussion of the views set forth in the address, we wish to enter a protest against the so-called "forecast" so often heard before the former was made public—namely, that it would be funny. That Mr. Swinburne has a refined sense of humour, and that his speeches sparkle with witty sayings, is well known to all who have enjoyed his contributions to the discussions at the meetings of the Institution; but it is no compliment to treat him as a confirmed humorist, whose main object is always to be amusing. The thoughtful and serious address before us alone is sufficient vindication of the earnestness and sincerity with which Mr. Swinburne applies himself to the advancement of the electrical industry, and to the elucidation of the problems which are met with on every side.

We venture to question whether the President was quite accurate in his suggestion that finality had been practically attained, either in telegraphy or in the design of heavy electrical machinery; there is still ample scope for invention and improvement in both branches of the industry, as there is in almost every branch of engineering, and we would remind our readers that the discussion of these subjects is still carried on with undiminished energy. The development of improved methods of transmitting signals and speech through space, with or without wires, at higher speeds and over greater distances, of automatic relays for submarine cables, of new insulating substances for the latter, and similar problems; the suppression of sparking, or of the commutator itself, the development of a satisfactory single-phase motor, and so on, all these are questions of immediate and pressing interest. The same activity is manifested in the realms of steam and gas engineering, to which, however, we shall refer later.

In his remark that "No man can be a complete electrical engineer," Mr. Swinburne seems to have furnished an adequate reason for the split between so-called theory and practice, which he justly laments. "To be an engineer you

must know both branches"—but who can do this, and live? *Ars longa, vita brevis*—and one cannot live on learning. Salaries are poor in the "scientific" sphere, which is necessarily closely associated with teaching; as the author puts it, "more fishes and more loaves" fall to the lot of the practical engineer, and as we see from time to time, the few to whom it is given to combine in themselves the qualities which appertain to both the scientist and the practician are exceedingly apt to devote their abilities solely to the latter function, and to relegate the study of abstract principles to the background. We fear that the distinction between the two classes cannot be abolished altogether, but the President's plea for a better understanding and a closer fellowship between them is worthy of the warmest support and commendation.

Mr. Swinburne's reminder, that we British are by no means so heavily handicapped by the lack of water-power in these islands as is often stated by superficial observers, is well timed, when so marked a tendency exists to deplore the assumed decline of British supremacy in the world of engineering and industry. No rational person could suppose that we should retain indefinitely the practical monopoly of manufactures that was formerly ours; but we can—and shall—retain our fair share of the world's work, despite the fevered efforts of the more sensational portion of our daily press to defeat that purpose. No one can justly estimate the harm that has been done by thus playing the game of our commercial rivals, who laugh up their sleeve as they look on at the tragi-comedy. But he laughs best that laughs last.

The simple but convincing reasoning, with which the President dissipates the hopes of those who look for the generation of electrical energy direct from coal on the lines of the primary battery, need not be regarded as equally fatal to the anticipation that a solution to the problem will eventually be found in some other direction; one path appears to be blocked, in the light of present knowledge—but only one; and the finder of the open doorway to success will reap a rich reward.

It is interesting to note that the subject which receives more attention in this address than any other is that of the theory of the steam engine. Mr. Swinburne not long ago made it evident, by his paper read before the Physical Society, that the subject of thermo-dynamics possessed a deep interest for him, and some of the results of his studies are manifest in the views—to some extent revolutionary—herein set forth. Not only does he pour contempt upon the antiquated collection—it cannot be called a system—of units, with which the engineer is compelled by binding custom to struggle; but with admirable courage he attacks the definition of entropy in common use, on the score that whereas this quantity is always defined with sole reference to a perfect engine, in which the cycle of changes is perfectly reversible, in point of fact this case never occurs in nature: in any existing heat engine the cycle is irreversible, and the entropy of the working fluid must necessarily increase. The object of the designer should be to trace all such increases of entropy, and prevent them as far as possible. Mr. Swinburne, happily, did not endeavour to explain to his audience the precise nature of that most puzzling conception, though he gave an amusing account of his attempts to induce authorities on thermo-dynamics to enunciate their views upon it. Instead he illustrated by means of a diagram based upon the θ, ϕ diagram the limitations of steam practice with respect to the upper and lower limits of the available range of temperature. The advantage of superheating was shown to consist mainly in the reduction of initial condensation in the cylinder, a point which we also have frequently emphasised in our columns. The additional energy which can be imparted to the steam by superheating is of little importance. To increase the range of temperatures the President showed that a second working fluid, such as sulphur dioxide, heated by the exhaust steam, was theoretically effective; experiments with this have been carried out in Germany, notably at the High School, Charlottenburg, but the final verdict has not yet been delivered. We doubt whether the additional outlay and complication entailed by the use of such a system will be found to be justified by the economy effected in the consumption of fuel; it seems more reasonable to suppose that the substitution of the steam turbine, which utilises the steam over a wider range, and may be still further improved, or the adoption of large gas engines, would be preferable.

The recommendation of the Institution of Civil Engineers with which the President concluded his remarks on the steam engine, to the effect that the abbreviation "B.Th.U." should be used instead of "B.T.U." for British Thermal Unit, on account of the confusion with Board of Trade Unit, is useful, though it comes rather late; we adopted this practice some years ago.

The President considers that the gas engine of the future will be compound, for though we already work with a high initial temperature, the greater part of this advantage is lost by the simultaneous elevation of the lower limit—the temperature of the exhaust gases. Thus the "mutivity," as Mr. Swinburne calls the ratio of the range utilised to the initial temperature absolute, is not much better than in the steam engine. The difficulties in the way of compounding the gas engine are enormous, while we cannot yet use the gas without cooling the cylinder, and thereby throwing away a vast quantity of heat in a most available form; these and other considerations suggest that the solution to the problem will be found in the evolution of a practical form of turbine fed with the hot gases at high pressure, a matter which is known to be receiving the earnest attention of inventors.

The President suggests that though the limits seem to be practically reached in many ways in the construction of dynamos, there may be a loophole for increase in the output of machines by, so to speak, deceiving the armature into the belief that it is running 10 or more times as fast as it really is running. This laudable object is to be obtained by adopting a principle well known in connection with the construction of verniers and in stroboscopic methods of measurement, but never before suggested in the present connection, so far as we are aware. By means of a special construction of the armature and field magnets, the magnetic flux is caused to rotate in the opposite sense to that of the armature, giving a relative motion at a far higher rate than the apparent motion. We cannot help feeling, however, that there is a nigger in this machine. Though we have not worked it out in detail, it seems certain that enormous fluctuations would take place in the strength of the magnetic flux, leading to such large induced variations in the strength of the magnetising current as to neatralise the advantage aimed at; in fact, the field magnet coils would become the seat of alternating E.M.F.'s, to counteract which they would have to be excited by means of an alternating current, of opposite phase! The power expended in the field magnets would, in fact, fully account for the augmented E.M.F. generated in the armature. We put forward this suggestion for what it is worth, as we have made no calculations in support of it.

Mr. Swinburne's remarks on the subject of secondary batteries, while they discourage the idea that any other material than lead can be utilised in the construction of the plates, are notable in that they practically ignore the alleged epoch-making invention of Mr. Edison. Our own opinion of this remarkably mysterious *cell* has been before our readers for many months, and is corroborated by the President's silence.

Mr. Swinburne pointed out the predominant importance of insulated cables in the electrical industries, and the extreme uncertainty which exists regarding their qualities, due, no doubt to the capricious and "unmechanical" nature of the materials—rubber, paper, &c.—employed for insulation. In this department it is certain that we are far from finality. The most unfortunate feature in this connection is the fact that cable makers, unlike those engaged in other branches of engineering, will not openly describe and discuss the details of manufacture of their products. The President is doubtless right in stating that the days of secret mixtures may be passing away; but we are of opinion that the process of insulating cables, especially those which are lead-sheathed, is still carried on under the protection less of patents than of secrecy. Until this state of affairs is changed, we cannot hope for rapid progress in cable manufacture. As for the possible use of zinc in competition with copper and aluminium for overhead conductors at very high pressures, we can scarcely regard this as feasible, having in view the low tenacity and extreme brittleness of zinc.

The ingenious mechanical condenser described by Mr. Swinburne appears to be worthy of attention, as it may constitute or lead the way to a simple and cheap substitute for the expensive and complicated synchronous motor for the purpose of improving the power factor, where this is found necessary. It is possible to regard this device, in fact, as a motor, the field being uniform and constant, and the armature oscillating instead of rotating.

The President's remarks on lamps and light are worthy of the closest attention, especially with regard to the possibility of converting electrical into light energy without the evolution of heat—a subject which has occupied the thoughts of scientists for many years, without making much progress. The reference to the use of iron wire resistances in series with glow lamps recalls to our minds a patent filed by one of us many years ago, in which this very principle was embodied, and for precisely the same purpose; unfortunately the attempt had a negative outcome at the time. We shall look for interesting results from Mr. Solomon's investigations.

In Mr. Swinburne's remarks on electric locomotives, he departed somewhat from the letter of his address, and described in some detail the construction of an existing and of an improved form of the oil-pump variable-speed gear, which looked very promising in theory, but might be found a source of trouble in practice. It is a remarkable fact that, although the pressing need of a good variable-speed gear has been before engineers from the earliest days, no really practical and efficient device has yet been forthcoming. There is absolutely no physical reason why such a thing should not be devised; but the mechanical genius who will solve the problem effectually and reap the usual reward of perpetual litigation with his imitators has so far not come forward.

Lastly, the President drew an enticing picture of the potentialities of electrolysis, and hinted at the production of metallic sodium at nominal prices—an eventuality fraught with immense possibilities to innumerable trades and processes. It is humiliating to think that the backward state of the subject in this country is to be ascribed to the ignorance and conservatism, not only of commercial men, who may be excused, but also of those who should know better—our scientific advisers.

Imperial Telegraphic Communication.

Our attention having been called to certain remarks made in our leading article of last week, we wish to take this early opportunity of clearing up a few possible misconceptions.

Our opening words were really only intended to point to one of the merits of the Address in the sense of presenting all the salient points on both sides of the question. With respect to our reference to "compilations from Blue Books," we think it well to add that there was no desire on our part to convey the impression that Mr. Bright's Address was in any way lacking in original matter, and we are now informed that the London Chamber of Commerce had Mr. Bright's Address in hand before some of these "Blue Books" were published.

It appears that Mr. Bright's public advocacy of a link between the "All-British" and the then proposed American Pacific Cable dates back several years, and, in any case, we did not mean to imply that he had merely taken up the idea of Mr. Mercer. We are also informed that, notwithstanding the statements in the Press, the Agent-General for New Zealand "knows nothing of" the proposed link.

With regard to our remarks anent the Pacific Cable Contract, it might be thought that had this been split up amongst the various responsible firms who tendered, the work could have been effected more speedily, and therefore the line would have been less behind the new Cape—Australia Cable in the arrangements for traffic. As it was, the latter cable was completed over a year before the same contractors carried out the Pacific line.

We also find that though in *one* portion of his Address Mr. Bright did actually recommend the routes of strategic cables being "unrecorded," from what he says elsewhere, it is clear that he really meant "keep secret."

We spoke of Mr. Bright "following the lead" of certain politicians; but, from facts which have since come to our knowledge, the "following of lead" seems more likely to be the other way about. This view becomes accentuated when we consider his much wider connection with the whole subject as a member of the electrical profession.

Whilst dealing with this topic, we must express our regret at being unable to reproduce the excellent map which accompanied Mr. Bright's Address. Apart from the prominence given to the Pacific Ocean, it is the only map we have seen in which the telegraph girdle can be followed unbrokenly in both directions—*i.e.*, going west by the new Pacific line to Australasia, and returning by either of the Eastern routes, or *vice versâ*.

King's College.—The following is a full list of the distinctive Chairs in the Engineering Departments and in the Science Faculty connected with the engineering student which it is desired to endow, and the amounts required for endowment in each case. The Council of King's College will be willing, if so desired, to assign to any Chair endowed in its entirety by a single donor the name of such donor in commemoration of *his* or *her* benefaction:—

Chairs.	Income per annum.	Capital at 3 per cent.
Science.—One physics	£800	£27,000
Two chemistry (together)	1,100	37,000
One geology	400	13,000
One bacteriology	500	17,000
Science Applied.—One engineering	800	27,000
One electro-technology	800	27,000
Three assistant Professors (together)	1,200	39,000
One metallurgy	800	27,000
One architecture (building construction)	400	13,500

For the *Engineering Laboratory* about £25,000 is required for additional buildings, a portion of which it is proposed to set apart for research. The additional equipment required includes a Willans, Belliss, Peache, or other high-speed engine, a Corliss engine, a Westinghouse or other direct-coupled gas engine, a Mond or Dowson gas plant, a Parsons or other rotary engine, a Galloway boiler, a Babcock or other large tube boiler, a Thornycroft or other Express boiler, a Green's economiser, a Worthington cooling tower, a compressed air-pumping plant, a Ledward or Körting ejector condenser, a Ledward evaporative condenser, a Pratt and Witney or other measuring machine, hydraulic accumulator tanks, &c. For the *Electrical Engineering Laboratory* about £50,000 is required to cover the cost of extensions, additional equipment and such charges as are absolutely required for the successful working of the department. The additional equipment includes the following:—Steam boiler, steam and gas generators direct-coupled, storage battery, direct and alternate current motors, transformers, switchboards, resistance frames, measuring instruments, switches, synchronising apparatus, shafting, repairing apparatus, traction apparatus, balancers, boosters, &c.

EXPERIMENTS ON THE APPLICATION OF PUPIN'S SYSTEM TO TELEPHONE CIRCUITS.*

By F. DOLEZALEK and A. EBELING.

(*Concluded from page* 970.)

Experiments on the Berlin—Potsdam Cable.

There lies between Potsdam and Berlin a cable about 32·5 km. long, laid by the Siemens & Halske A.G. a few years back for the German Postal Administration, to relieve the pole lines connecting the two places, and for intermediate local traffic. The cable contains 28 pairs of conductors of 1 mm. copper wire, with air space paper insulation, of the usual Siemens & Halske A.G. construction. This cable, with the exception of the portion in Berlin itself, is of U.G. type, lead-covered, armoured and compounded; the portion in Berlin, being drawn into tubes, is without the compounded covering. Of these pairs 14 were left in their original condition, a most convenient arrangement, as it was thus possible by direct comparison between the equipped and unequipped lines to obtain a clear idea of the improvement gained. It was, of course, necessary in order to prevent disturbance of the cable that the inductance coils should be introduced at the junction boxes already existing which connected the individual manufacturing lengths. The distance between the coils had therefore to be limited to certain definite figures. Inserting them at every second box, a distance of about 1,300 metres between the coils was secured. Each coil introduced a resistance of about 4·1 ohms in each wire of the circuit, and an inductance of about 0·062 henry. As the resistance of the cable conductor, with coils included, amounted to 23·5 ohms per kilometre, while the wire-to-wire capacity was about ·037 mfd. per km., the value of β, the attenuation constant, using the abbreviated formula for its calculation, became 0·0106.

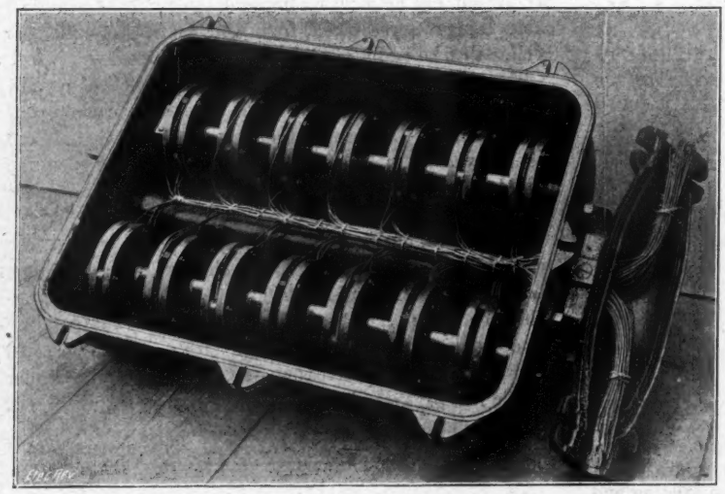


Fig. 3.

The self-induction of the simple metallic circuit measured with an alternating current of 900 periods per second, gave 0·0003 henry per km. The attenuation constant for the simple circuit was therefore 0·06 (at 900 periods). Consequently by insertion of the coils the inductance was increased 200-fold, and the attenuation constant reduced to one-sixth.

As a result of this large reduction in the attenuation a considerable improvement in audition was to be expected, and did, in fact, result. Comparing an equipped circuit with one of the simple circuits between Berlin and Potsdam, the length of which as mentioned above was 32·5 km., an enormous difference was noticed in the loudness of the tones. While with an unequipped line the distance from the receiver for good audition could not exceed half a metre, with the equipped line audition was perfectly distinct at 10 metres distance, *i.e.*, at the opposite end of the room. This experiment was conducted with the ordinary type of Siemens subscribers' instruments, the transmitter being actuated by two Hellesen cells. As there were at disposal 14 equipped and unequipped circuits, it was possible to experiment on longer circuits by joining single lengths in series.

Joining then three lengths in series afforded a circuit of about 97·5 km., and comparing the equipped and simple circuits, the difference between the two was more striking than in the first case, when the speaking was carried on over a length of only 32·5 km. While it was possible with the equipped line to hear clearly at a good distance from the receiver, with the unloaded line the limit of audition had been reached, confirming with exactitude the results theoretically arrived at.

With five lengths joined in series, or a circuit of about 162·5 km. on the unloaded line, it was only a very accustomed ear that could recognise the slightest movement in the telephone diaphragm, while with the loaded line a very distinct articulation was produced. By direct comparison of the loaded circuit of 162·5 km. with the unloaded circuit of 32·5 km. the loudness of tone was found to be approximately the same. Over 13 lengths in series, or about 422·5 km., reception was still possible, but the tones were very weak.

Comparing an overhead circuit between Berlin and Potsdam of 2 mm. bronze wire with a loaded circuit in the U.G. cable of the same length, the loudness of speech was approximately the same. The results depended a little on the state of the atmosphere. In good weather the loudness on the overhead wire was a very little greater than on the cable, while in bad weather the converse obtained, the cable circuit being a little louder than the overhead.

The result of this comparison is most noteworthy, inasmuch as it shows that by application of Pupin's system, a cable with a conductor of 1 mm. diameter can be rendered equivalent in speaking capacity to an ordinary unequipped overhead wire of 2 mm. diameter, or four times the section. Theoretical calculations show that this result was to be expected, but still it presents a striking confirmation of the correctness of Pupin's views. The arrangement of the inductance coils was very simple. Each set of 14 coils of annular construction was inserted in an iron box, and the necessary connections to the cable made by means of a special connection box, both being subsequently filled up with compound. Fig. 3 gives a view of such a box with the connections complete.

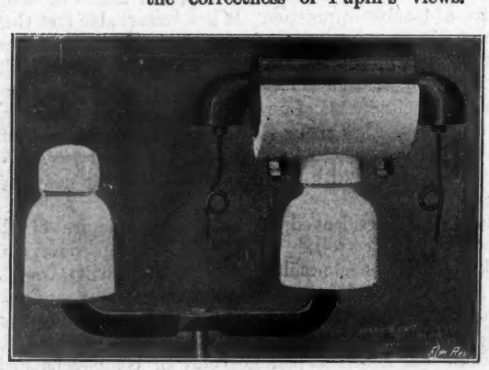


Fig. 4.

Experiments on Overhead Wire.

After this satisfactory conclusion of the cable experiment, the German Postal Administration placed at the disposal of

* *Electrotechnische Zeitschrift*, Vol. XXIII., p. 1059.

the Siemens & Halske A.-G. for equipment a bronze overhead line of 2 mm. diameter, about 150 km. long, connecting the cities of Berlin and Magdeburg, and serving for the inter-communication of six intermediate stations connected along the line; this could be compared with a line of 3-mm. bronze wire about 180 km. in length, serving for direct communication alone between the same places.

Before the loading of the 2-mm. circuit, the communication over the whole length was naturally inferior to that on the 3-mm. circuit. The 2-mm. line was now equipped with Pupin coils, a condition being imposed that no interference with traffic should be caused, the compliance with which presented no difficulty. At every 4 km.

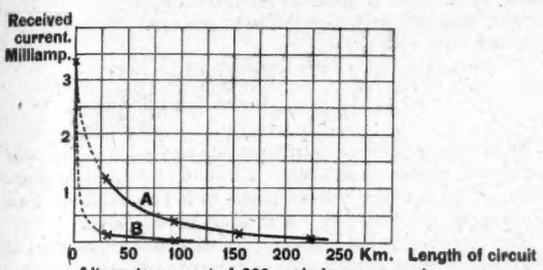


Fig. 5.

distance was inserted a coil of about 6 ohms resistance and 0·08 henry inductance. On the completion of the loading, the speech over this line was considerably louder than over the 3-mm. line. The installation of the coils was so arranged that at the poles where they were to be inserted double insulators were affixed, on one of which the coil had been mounted as shown in fig. 4, and in this manner the alteration was effected without affecting the insulation of the line. In the course of this experiment it was discovered that each such coil must be provided with a lightning protector; this could have been so arranged that at both ends of the coil the discharge would be led to earth, but as actually erected the coils were bridged by a vacuum protector.

Berlin—Potsdam Cable.—Quantitative Measurement.

The experiments given above were rather in the direction of qualitative results, and in order to gain direct numerical values of the decrease in the attenuation coefficient with the introduction of inductance, measurements were conducted using alternating currents of low intensity and high frequency. For this purpose an alternating current of 900 or 400 periods per second, and of a few milliamperes intensity, was applied at the sending end of the circuit, and the current at the other end measured on a sensitive mirror electro-dynamometer. Exact compliance with the theoretical treatment given above, in which the transmitter alone possesses inductance, was difficult to attain in actual practice, as the sensitive alternate current galvanometer had a considerable inductance. It was, therefore, preferred to conduct the experiments under conditions closely agreeing with those of actual working rather than to adopt the closest approximation to those demanded by theory, and for this purpose the receiving apparatus was given an inductance (0·4 henry) and a resistance (400 ohms) equal to that of a subscriber's telephone set.

In fig. 5 is given a series of measurements with a frequency of 900, the current at the sending end of the circuit being in this, as in all other measurements, 3·38 milliamperes. The ordinates give the currents at the receiving end, also in milliamperes, and the abscissæ give the lengths of the circuit in kilometres. The length, when over 32·5 km., consisted of other pairs of conductors in the same cable connected in series, which was permissible, as no appreciable induction (cross talk) existed between the different pairs.

From the telephone experiments it was evident that the current on the cable circuit with added inductance was far greater than on the simple circuit. Both curves show clearly the exponential form of decrease demanded by theory. On the single length between Berlin and Potsdam, the current on the Pupin circuit was 1·2 milliamperes, and that on the ordinary circuit 0·17 milliamperes, so that the former was seven times the latter. In accordance with the theoretical equation, the ratio between the currents on the Pupin cable and the ordinary cable increases enormously with their increase in length, so that on a length of 97 km. the transmission of speech on the Pupin cable would be 48 times better than that on the ordinary cable. The attenuation reached equality when the former was five times the length of the latter, a result in very good agreement with the previous telephone experiments. The extraordinary superiority of the cable loaded with inductance, as compared with one almost inductanceless, is most apparent.

In fig. 6 are plotted the results of similar measurements, with a frequency of 400 per second. The difference between the loaded and unloaded is still considerable, although the damping in the ordinary cable is notably less at the lower periodicity. A comparison of figs. 5 and 6 shows that the ratio between the attenuation for 900 and 400 periods respectively is as 1 : 1·6 for the Pupin cable, and for the ordinary cable as 1 : 6.

The cable loaded with inductance transmits all oscillations practically with the same efficiency, and this fact explains the clearness in the audition through such a cable.

Overhead Wire, Berlin—Magdeburg.

With the same instruments as used for the cable, measurements were also conducted on the overhead wires between Berlin and Magdeburg—viz., on the 150 km. of the 2-mm. conductor, both before and after loading with inductance, and on the 180 km. of 3-mm. ordinary conductor.

The intensity of the arrival current at 900 periods per second was on the 150-km. length of 2-mm. wire without coils, 0·53 milliampere; on the 150-km. length of 2-mm. wire with coils, 2·20 amperes; on the 180-km. length of 3-mm. wire without coils, 0·84 ampere. The insulation of the line during these experiments was about 25 megohms per km.

The introduction of inductance on the 2-mm. conductor thus raised the current at the receiving end from 0·53 to 2·2 milliamperes, or four-fold, and to a value considerably

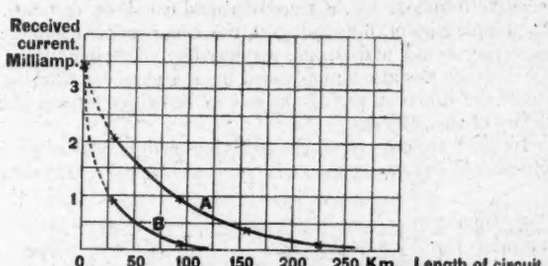


Fig. 6.

above that on the 3-mm. conductor. The greater length of the latter would account for a very small portion of this difference. On still longer lines, just as in the case of cables, the improvement gained by the insertion of the inductance coils would be still more marked.

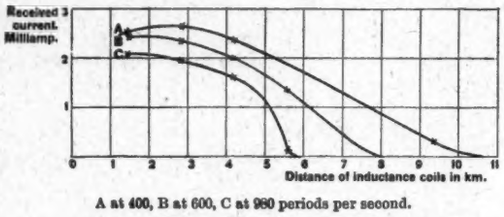
To prove the effect of insulation resistance on the transmission of the current, measurements were made at different states thereof, and these showed that the 2-mm. Pupin conductor was influenced to a greater extent than the 3-mm. ordinary conductor, but even with the very low insulation of 1 megohm per km. the Pupin circuit was considerably superior to the 3-mm. conductor. The conclusion from these results is that for telephone conductors on Pupin's system one quarter the weight of copper hitherto used will give the same efficiency, or, in other words, at least four times the distance can be covered by the same weight of copper.

The Effect of the Distance of the Coils.

The essential point of Pupin's invention, as already developed, is the recognition that the addition of inductance

can cause a diminution of the attenuation only when the distance between the coils is a fraction of the wave length of the alternating current acting along the line. With great distance between the coils a reflection of the wave arises, and the attenuation soon becomes greater than that on a line with low inductance.

These experiments were conducted on an ordinary air space paper cable, with conductor of 0·8 mm. diameter, and a length of 28 km. at 980, 600 and 400 periods per second. The values per kilometre of the self-induction and capacity (wire to wire) were 0·075 henry and 0·04 mfd. respectively, and were the same throughout the experiments, as was also the effective value of the current, 3 milliamperes, sent into the line. The wave lengths were as follows, corresponding to the frequencies given above:—For 980, 12·9 km.; for 600, 21 km.; and for 400, 31·5 km.



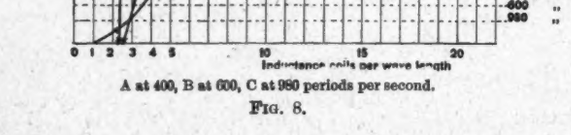
A at 400, B at 600, C at 980 periods per second.

Fig. 7.

Twenty inductance coils of 0·11 henry each were introduced into both wires of the circuit, but these could be separately grouped at 20, 10, 5 or 2 spots, so that the distances between the groups could be varied from 1·4 to 10 kilometres, while the total inductance of the whole circuit remained constant.

In fig. 7 the curves for the specified frequencies give the current received at the end of the 28-km. circuit as a function of the distance between the inductance coils. These show that after a certain distance the fall of the current is rapid, and occurs earlier and with greater abruptness the higher the frequency. With a distance between the coils of 6 km., the alternating current of 980 periods per second is totally reflected, and even with the use of the most sensitive telephone not a trace of sound could be detected. At frequencies of 600 and 400, the distances for complete throttling were 8 and 10 km. respectively. The increase of the distance was also accompanied by a successive filtering out of the different periods, as was to be expected from the theory of the subject.

In fig. 8 the current at the receiving end is plotted as a function of the number of coils per wave length. Between



A at 400, B at 600, C at 980 periods per second.

Fig. 8.

the numbers of 2 and 6 per wave length the current rises from zero for all the periods; the lower number furnishes a definite critical limit below which a perfect throttling of every frequency occurs, and therefore telephonic communication is impossible.

The experiments conducted by speaking over a line with successive points of aggregated inductance are very interesting. While on a line with correctly spaced inductance coils speech is received with remarkable clearness, owing to equal attenuation of waves of all frequencies; with too great distances between the coils nothing but an unintelligible, confused rumbling is heard.

Application of the Theory.

The equation deduced above for the effective current in the receiver—

$$I_e = \frac{2\,I_g}{\sqrt{e^{2\beta\xi} + e^{-2\beta\xi} + 2\cos 2\alpha\xi}},$$

is not directly applicable to the foregoing measurements, because the impedance of the receiver cannot be considered as a vanishing quantity. To gain, however, a closer approximation to theory, a series of measurements was conducted on a cable circuit 97 kilometres in length, equipped with coils (fig. 3), with different impedances in the receiver and at a frequency of 900, so that, with little doubt as to accuracy, the value for zero impedance could be extrapolated. The values of α and β were calculated from the particulars of the cable by equations (5) and (6). The values of ξ and I_g were 97 and 3·35 respectively. The currents received with the different amounts of impedance were as follows:—

Impedance	2,127	Milliampere	0·481
"	2,540	"	0·398
"	4,040	"	0·278

By simple graphical extrapolation, the current at zero impedance evaluates between 1·2 and 1·7 milliamperes, which is in very close accordance with the value of 1·45 milliamperes calculated by the formula given above.

The experiments here given prove that by the insertion of inductance coils in telephone circuits in the manner described by Pupin, the great advantages theoretically claimed are obtained in actual practice, and that a new field is now opened for a wider extension of telephonic intercommunication, for even the problem of trans-Atlantic telephony might be considered as within the bounds of possibility; but, unfortunately, the cost would be excessive, and the technical difficulty of the construction and submersion of a cable with added inductance coils in such great depths must be considered as lying outside the realms of practicability, though for shallower waters, as the North Sea and Baltic, the laying of such a cable may be deemed to be not utterly impossible, thus securing direct communication between London—Berlin and Berlin—Copenhagen.

A CRITICISM OF PRESENT-DAY CONTINUOUS-CURRENT DESIGNING.

By FRED. W. DAVIES.

1. *Introduction.*— Continuous-current machines have been brought to a high grade of excellence within the past few years, and, compared with any other class of machines working on either electrical or mechanical principles, they are as nearly perfect as can reasonably be expected. Their high efficiency, cool running and sparklessness afford ample proof that the thought and care bestowed upon their production has been spent to good purpose. The question of dynamo and motor-designing is one that is now so well understood, that it is not an easy matter to suggest any improvement. All phases of continuous-current designing have received attention from experts, and every part of a continuous-current machine has been subjected to innumerable improvements at the hands of indefatigable inventors, until it would almost seem that the subject was exhausted. In fact, the state of the available knowledge on this subject is so advanced, that to offer "a criticism of present-day continuous-current designing"—not necessarily calling attention to faults, but rather to some points which appear to need emphasising—to offer a little friendly criticism, although well and modestly meant, may, perhaps, appear to some to savour of technical heresy. Such, however, is not the case, as will be seen later on. Honest criticism is always useful, even though mistaken, and probably amongst no class in the community is criticism so rife as amongst electrical engineers.

There are several ways in which the design of some of the continuous-current machines at present on the market—it is purposed, herein, to deal only with machines of the continuous-current type—may be modified with advantage. Not that there is room for any material improvement in a matter such as the efficiency of a machine, for instance:

nevertheless, there are, undoubtedly, some points, which, if they were more generally recognised and observed, would lead to greater economy and convenience in manufacture. Such criticism, if it does nothing else, will, perhaps, serve to stimulate thought—always a valuable process.

1. *Armature Design.*—The armature is the most vital part of a dynamo or motor; and to it attention must first be turned. It is the armature that is generally the seat of any trouble causing the breakdown of a machine; and, considered from an electrical point of view, it is to the design of the armature that the success or otherwise of a design is nearly always attributable.

The first point presenting itself for consideration is the type of armature core to be used. Of the two general types, the drum and the ring, the drum is the more commonly used. This is as it should be, for there are several points in its favour. For one thing, there is less idle wire on a drum than on a ring armature, resulting in a lower resistance of the whole armature, and a lower self-induction per coil. Another advantage is that, owing to the greater cross-section of iron in such a core, a stronger field may be employed. And, lastly, it is better suited to former-winding—so much in vogue at the present time. Such are the reasons for which, in most instances, the drum core is preferred. Upon the question, however, as to whether any given armature shall be of the plain, or of the toothed variety, there is not such a unanimity of opinion. As a matter of fact, neither can be said to be the best for all cases. The toothed drum core, however, probably on account of the mechanical protection it affords the coils and the economy it affords in the excitation of the field magnet, the latter being brought about by the reduction in the length of the air-gaps, is coming more and more into favour for all types and sizes of machines. This is to be regretted, for, although it is certainly the better type to employ in many instances, yet its universal application is a mistake. The principal economy effected by the use of a toothed core is that the length of the air-gaps is reduced, thus not necessitating such a large number of ampere-turns on the field magnet. The less the number of poles on a machine, the longer should the air-gaps be, proportionately; otherwise the commutation will not be good. Consequently, the air-gaps of a two-pole machine should be the longest, in proportion. The length of air-gap in a two-pole machine having a plain armature, which is necessary in order to allow sufficient room for the conductors, minimum clearance, &c., will not be longer than is required in order to obtain sparkless commutation. The use of a toothed core on such a machine will not, therefore, result in any economy in field-magnet excitation. In multipolar machines, the minimum length of air-gap consistent with sparkless commutation is less, proportionately; in these, therefore, toothed cores may with advantage be used.

A fact well known to electrical designers is that, in a toothed armature machine, the commutation is improved by working at a high induction in the armature teeth. This is owing to the armature reaction being reduced, by reason of the high reluctance thereby interposed in the path of the cross-magnetising flux. In order to have a high induction in the teeth, these have to be made narrow. This plan is not a good one, for the hysteresis and eddy current losses in the teeth are materially increased thereby; and these increased losses cause undue heating of the core. It is not necessary to reduce the section of the teeth in order to minimise armature interference: this result may be attained equally well, and without the disadvantages attendant on the use of narrow teeth, by simply increasing the length of the air-gaps.

It is essential that the larger sizes of armatures should be ventilated, so as to ensure cool running. For the smaller sizes ventilation is not relatively of such importance. It is of little use to provide ventilating ducts in a plain core, unless gaps are left at intervals in the winding of the periphery; and yet armatures having cores of the plain drum type which were ventilated thoroughly, but with the ventilating ducts completely covered by the peripheral winding, have occasionally—though fortunately not often—been constructed. Such a method of construction is practically useless as far as ventilation is concerned.

In an open type machine it pays to provide means for ventilating the armature, for in such a machine the hot air emitted by the armature can get away from the machine. In a machine of the enclosed type, however, the hot air from the armature is retained within the shell, or carcase, of the machine, and in such a case the employment of ventilating ducts in the armature does not materially reduce its temperature rise. It is, therefore, a fallacy to take elaborate precautions to minimise armature heating in an enclosed motor, as is sometimes done.

Generally speaking, it is not advisable in a former-wound armature for a bipolar machine to use the barrel type of winding. The ends of a bipolar barrel winding are unnecessarily bulky, owing to the end windings being carried out in a straight line with the peripheral windings. The evolute, or Eickemeyer, winding, which—to all intents and purposes—is a barrel winding with the ends bent down on to the ends of the armature core, is certainly more economical as regards the end space, in a bipolar machine. The evolute winding is generally to be preferred for bipolar machines, on account of the economy in space effected by its use. For multipolar machines, it is advisable to use the barrel type of winding, as the arc embraced by each coil is proportionately less, and, in consequence, the ends are not so bulky.

3. *Field-Magnet Design.*—The number of poles in a field-magnet is a point which greatly influences the performance of a machine; and one, moreover, which does not always receive the consideration it should do. It is a question of far-reaching import; and it may not be out of place to give a brief statement of the principles which should determine the number of poles to be given to a field-magnet. An increase in the number of magnet poles permits a decrease in the length of the air-gaps. The greater the number of poles, the less the length it is necessary to give to the air-gaps in order to obtain sparkless commutation. Such a reduction in the length of the air-gaps will be accompanied by a corresponding reduction in the size of the magnet, and in the number of ampere-turns on it. This is the principal advantage gained by increasing the number of magnet poles. A secondary advantage is that the armature of a multipolar machine offers better facilities for ventilation than does the armature of a bipolar machine, though this is not such an important advantage as the foregoing one. What then, are the limits, if any, to the number of poles to be used in any given magnet? In the first place, it should be remembered that the periodicity of the magnetic reversals, through which the iron of the armature passes, varies directly as the number of poles in the magnet. Hence, seeing that a high periodicity involves the production of heat in the armature core, owing to hysteresis and eddy current losses in it, it is well not to increase the number of magnet poles indefinitely—especially in the smaller machines, which are usually run at high speeds. Then, again, the multiplication of magnet poles causes the cost of labour in manufacture to be increased. This, also, tends to restrict the use of multipolar magnets to the larger sizes. The use of multipolar magnets for small motors of the enclosed type, although resorted to sometimes, is, nevertheless, a plan that has little to recommend it, resulting, as it does, in undue heating of the armature, and, in some cases, in a higher cost of manufacture.

Magnet poles are sometimes bored out so as to be non-concentric with the armature, in order to improve the commutating properties of a machine. This it undoubtedly does. The advantage derived from non-concentric poles is on account of the field being more rigid, magnetically: that is, less easily distorted by the current in the armature winding. The fact of the air-gaps being longer at the polar horns than at the middle of the pole-pieces tends to keep the magnetic flux in the middle of the pole-pieces; for any distortion of the flux from this position results in a virtual lengthening of the air-gaps, and this increase in the length of the air-gaps acts as a check on the distortion of the field. As will readily be understood, a field which is affected by every little fluctuation of the load will cause sparking at the brushes, for it is quite impracticable for the position of the latter to be continually varied to suit the alterations in the load. Hence, anything which prevents distortion of the field, such as the use of non-concentric poles, &c., naturally improves the commutation, and is to be commended.

One would expect that in such a simple matter as the

requisite cross-section to give to the yoke ring of a magnet of the "ironclad" type, there would be no divergence of opinion amongst designers and manufacturers. Yet, in some machines that have come under the writer's notice, the yoke ring, which was of the same metal as the cores (cast-steel), was made of practically the same cross-sectional area as the cores themselves. This, it need hardly be said, is entirely unnecessary. The yoke ring of a magnet of the "ironclad" type, if of the same material as the cores, should be one-half of the cross-sectional area of one of the cores; or, if of different material, should be of sufficient area to carry one-half of the lines of force carried by one of the cores.

4. *Concerning Brush Gear.*—An essential feature in connection with the brush gear of a machine is that it shall be easily accessible for adjustment and brush renewals. This desideratum is usually realised in open type machines; but not always in enclosed motors. Often, there is a difficulty in getting to the brush gear of enclosed motors. With the idea, probably, of designing a compact machine, the room allotted to the brush gear is sometimes rather limited. This should not be so; it is well to make the carcase of the motor sufficiently large to allow ample room for attending to the brushes and brush-holders, even if the machine has to be made somewhat larger in consequence.

5. *Some Points Relating to Mechanical Design.*—The *commercial* success of a machine depends as much upon its general mechanical design as upon anything else. A machine may give excellent results as regards efficiency, commutation and cool running, and yet it may not be a commercial success. In these days, when there are so many excellent machines on the market, satisfactory working is not the guarantee of commercial success that it was a few years ago. One of the principal factors which determine whether any design of machine will sell well or not, is its general appearance; and this depends principally upon its mechanical design. It should be smart, and of pleasing appearance, for first impressions go a long way with the average buyer of dynamo-electric machinery.

To anyone conversant with works management, it is a well-known fact that in small machines the cost of labour is comparatively high and the cost of material low; whilst, as the size of the machine is increased, the cost of material assumes greater importance, and the cost of labour lesser. What is the import of this fact? Simply this: that the smaller sizes of machines should, in order to attain the maximum economy, be designed so as to necessitate as little labour as possible, even at the expense of material. There are several ways in which an economy in labour may be effected which will suggest themselves to anyone accustomed to designing mechanical details. The larger sizes of machines should, on the other hand, be designed so as to employ as simple castings as possible. This amounts to saying that large machines should be made of a large number of different parts. Owing to their requiring to be machined and fitted together, the cost of labour will be somewhat increased; but, as previously pointed out, the cost of labour in a large machine is comparatively unimportant.

A fault which may be noticed in some enclosed motors is, that the fixing lugs, or feet, are too close together, resulting in the machines being unstable and liable to spark, on account of the vibration to which they are subjected. It is well to arrange the fixing lugs so as to give a large base, for the running of the motor is certain to be improved thereby, especially if there is any tendency to sparking at the brushes.

6. *Concluding Remarks.*—Excellence of design is attested by cheapness of production, as well as by the satisfactory working of a machine. To produce a machine cheaply, it is necessary for a designer to be thoroughly acquainted with the class of tools used by the firm for which he is designing, and with their capabilities and limitations. Unless these factors are taken into account, one cannot be certain that a machine can be made at a profit, for the tools in the shop may prove unsuitable for its manufacture. Since the tools cannot very well be altered to suit any particular design, the only alternative is to consider what design of machine will be best suited for manufacture with the tools in the works, and then to design accordingly.

STANDARDISATION OF CAR DETAILS.

"As you were," and "Mark time," are the boiled-down results of the report presented to the recent meeting of the A.S.R.A. by the committee deputed to consider the question of standards at the last annual meeting. The committee consisted of some of the ablest street railway men in the States, and the report was reproduced *in extenso* in the *Street Railway Journal*. Except in the case of motors, the committee advocated no radical change, but rather an adherence to the existing forms and dimensions already standardised, after exhaustive inquiry, by the Master Car-Builders' Association.

It was felt to be impossible to outline what would be considered a standard motor, but we do not agree with this so readily or entirely as with the next admission that, on

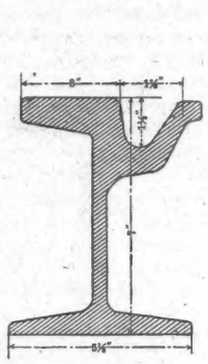


Fig. 1.

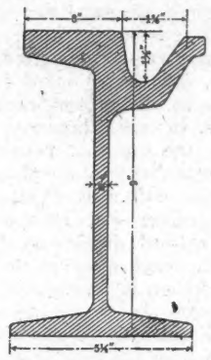


Fig. 2.

account of the great variation in the conditions of operation, it is not practicable to standardise motors of certain horse-power for certain weights of cars. That is a point on which we should be sorry to see any attempt at rigidity; but, within wide limits, the general form of the motor would not require to deviate from the standard.

The committee also takes notice of the advent of alternating-current motors in traction, and advances that as another reason against immediate stardardising.

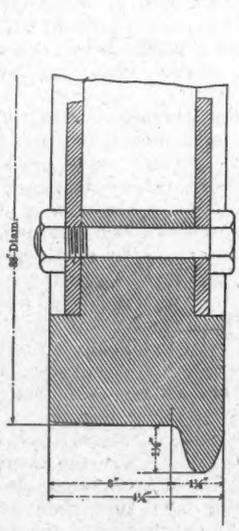


Fig. 3.

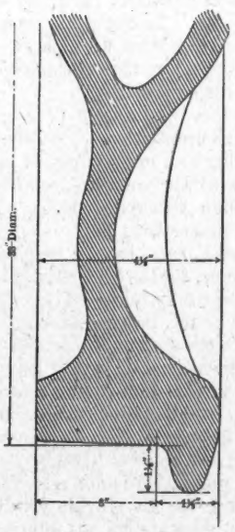


Fig. 4.

The remarks on rails are of no great direct interest to us, as we are not allowed to use the T rail for all purposes, as recommended; and we do not think the girder rail shown is any more serviceable than the form generally used on new lines in this country, although the shape of the groove is

probably better adapted for self-cleansing than ours. One of the points on which considerable stress is laid is that, owing to the number of cases in which suburban and inter-urban cars enter towns over the tracks of the town lines, the table and groove of the girder rail should be made wide and deep enough to take wheels having treads and flanges of a size sufficient to enable them to run with safety at the high speeds usual outside the towns. The table of the rail should be 3 in. wide, and the groove deep enough to take a $1\frac{1}{8}$ in. flange.

This is just the problem we in England shall have to face very shortly, if we are ever to run high-speed cars from outlying districts to the centres of towns. At present a groove of the width and depth required is out of the question, because of restrictive regulations, but the restrictions will have to be removed in special cases to benefit the vast majority of the population who do not own tradesmen's carts or private carriages.

The red-hot advocates of steel-tired wheels will be pleased to hear that such a wheel (fig. 3) is recommended for high-speed cars, chiefly on account of the lessened liability of flanges breaking on curves. The construction of this type of wheel differs radically from that usual over here. Fig. 4 shows the proposed standard chilled wheel, which is tacitly recommended for urban use. We are confident that the steel wheel school would not have so many adherents in England if a flange section, such as that shown on fig. 4, had been adopted from the first.

Now, if there is one thing more than another that wants standardising, it is the single truck; yet the committee feels that "it is inopportune to recommend any particular design of trucks for motor-car service, especially for single-truck cars, except such parts of trucks as wheels, axles, bearings and journal-boxes." We fear that too much regard was had for the manufacturer in arriving at this decision. Everybody makes a special truck; but, taking a general view, the best of those trucks are identical in all but more or less trivial details. It is just those differences that make one truck totally unlike another to the storekeeper, and add so much to the expense of maintenance.

The M.C.B. standard axle is recommended for cars of every size, also the journal-brasses and boxes, dust-guards and key-seats, which are all drawn in detail in the report.

We believe that the majority of axles under cars in England, whether of American or home manufacture, have the spur-wheel key-seats cut in the body of the axle. Consequently nearly every axle that breaks does so at the beginning of the key-seat next the wheel hub. The M.C.B. standard swells out the axle for the gear-wheel fit, and cuts the key-way along the enlarged section.

Variation in component parts extends even to such simple things as brake-heads and shoes, and every new make of truck in a car shed means a pair of new patterns for the shoes alone on a single truck.

The Committee recommends for adoption one form of head and shoe, which, from the drawings, appears to embody the chief excellencies of the types best known in England.

We think it hardly necessary to attempt to standardise the process of painting. In England, at all events, although every paint-shop foreman has his little idiosyncrasies, so long as the work is done conscientiously and with good material, the results obtained in the end are very much the same, and the small variations in practice do not lead, as in other departments, to lack of interchangeability, duplication of stock parts, and more expensive labour charges.

We regret, with the Committee, that it was impossible to obtain reports from the members to whom were assigned the subjects, "Standard Overhead Construction for High Speed City and Suburban Service, including Trolley Wheels," and "Car Bodies for City and Suburban Service, including Ventilation," and we hope that the next Committee will be composed wholly of men as energetic and cautious as Messrs. Heft, Beggs, Newman, Cormette and Laffin.

Lamp Contract.—We are informed that Messrs. H. Binko & Co. have received renewal of their contracts for electric supplies with the New Zealand Royal Mail Steamship Co., White Star Line, and another leading mail steamship company.

GAS ENGINES FOR CENTRAL STATIONS.

Seeing that in this country, and on the Continent on a more extensive scale, gas engines of large power are being rapidly adopted for driving electric generators, both direct current and alternating, though certain central stations which had primarily been run with gas engines have reverted to steam-power, it is evident that there must be some sufficient explanation why gas engine installations have in some cases failed to fulfil the station requirements. King's Lynn and Leyton may be quoted as recent instances. The application of power gas to central station work must be very problematical to electrical engineers, who are interested in the question of cheaper power but unfamiliar with the special conditions necessary to the successful application of this agent.

In regard to the capability of the gas engine *per se* to fulfil the requirements, Mr. C. H. Williams, in a paper read before the National Electric Light Association at Cincinnati, U.S.A., points out that the efficiency of the gas engine has already been carried far beyond that of the steam engine, and the margin of possible improvement is considerably greater. With prevailing steam pressures, the theoretical efficiency of a steam engine is not equal to the actual working efficiency already obtained with gas engines.

If we assume a boiler pressure of 150 lbs. absolute and an exhaust pressure of 3 lbs. absolute, a steam engine of perfect theoretical efficiency would give us but 26·5 per cent. of the thermal energy which is transformed into mechanical work, while 28 per cent. has already been obtained with the gas engine.

It is a fact that the possible efficiency that may be obtained under ideal conditions with a gas engine equals and surpasses the possible efficiency of the steam engine operating with prevailing pressures by some 180 per cent., and even at the present time, when we are just beginning to look into the possibilities of the gas engine field, we are obtaining efficiencies with our relatively crude apparatus which are far better than the best that the steam plant would be able to produce under ideal theoretical conditions, even after the years of careful study and almost endless experimental work which have been devoted to it. With these facts in view, we cannot but admit that the subject is one of the greatest interest and importance.

Continuous running for long periods may be instanced by quoting from the paper on "Power Gas and Large Gas Engines for Central Stations," read by Mr. H. A. Humphrey before the Institution of Mechanical Engineers in December, 1900:—"Continuous runs without stoppage have been made during the years 1898 and 1899 of from 25 days to 138 days." At Leyton, gas engines with dynamos were installed at the rate of two a year until eight units were in use, which may be taken as proof that from the generator-driving point of view the engines must have been satisfactory.

In regard to driving alternators in parallel, this point has also been satisfactorily disposed of, by so arranging the number of, and power of, the impulses in conjunction with a well proportioned fly-wheel effect, that the cyclic regularity can be brought up to that required by the alternator.

However, it must not be overlooked that the gas engine has certain peculiarities which have to be provided for, and one of the most important of these is premature ignition. The effect of premature ignition is to considerably increase the maximum pressure in the cylinder, and to increase the cyclic irregularity as well by increased maximum pressure as by the higher compression in the previous stroke.

Firing in the exhaust, which occasionally happens, causes a very loud report, sufficient to be considered a nuisance in a populous neighbourhood. The noise of the exhaust from gas engines of considerable proportions must be effectually muffled, as otherwise it is a serious source of annoyance. This can be done with greater certainty than the absolute prevention of firing in the exhaust with such gas as natural gas, coal gas or producer gas, having a sensible proportion of hydrogen, or hydro-carbon gases.

Vibration has been a source of trouble, but this has probably been due to the foundation having been too light in proportion to the power of the engine, and to inadequate balancing of the reciprocating parts.

No doubt a very serious mistake has been the adoption of comparatively small sizes of gas engines and producer plant in the first instance, involving a proportionately very large floor space compared with steam practice; this may not appear to be a matter of great importance in the original plant, but as soon as extension is considered, it becomes an obstacle. To refer again to the Leyton gas installation, by the time the eight 50-H.P. engines and gas plant had been installed, the space occupied by this system, when the question of extension arose, was a considerable objection, as steam engines of very much higher power, direct coupled to dynamos, would occupy a much less space, and would be much more in line with the station engineer's experience.

Mr. C. H. Williams goes very fully into a comparison between steam power and gas power, showing that in stations below 1,000 H.P. producers and storage capacity will cost more than would an equivalent boiler plant, and we feel confident that most of the gas installations which have been converted to the steam system have been so dealt with mainly as the result of the adoption of such small units of producers and engines as to cause the increased interest, rent charges, &c., to counter-balance the reduction in fuel cost.

The adoption of the gas engine involves the question of the most serviceable and economical quality of gas to be employed. Coal gas and water gas, besides being expensive, are found to give results which are not as satisfactory as can be obtained from gas of lower thermal value. Coal gas taken from the local gasworks has the advantage of being constant in its chemical composition and thermal value, but the price demanded is, owing to the costly apparatus employed to render it suitable for domestic purposes, higher than is desirable when the gas has to be applied for power purposes in gas engine cylinders. Further, it is found that carbonic oxide, or carbon monoxide gas, will give even better results in gas engines than hydrogen and hydrocarbon gases, so that when a station of any considerable size is under consideration, coal gas from the local gas works goes out of consideration.

Mr. J. E. Dowson* considers that gas specially made for gas engine purposes should have a calorific value of at least 1,200 calories per cub. metre (134·7 B.Th.U. per cub. ft.), and that the content of hydrogen should be 15 per cent. to ensure fairly prompt ignition. But experience with gaseous mixtures, such as blast furnace gas, has proved that the above proportion of hydrogen is not necessary, if specially arranged tube ignition is employed. The presence of hydrogen in proportions above 5 or 6 per cent. has a tendency to give such a prompt ignition as to give a high initial pressure at a point of the crank angle where it does not give the best turning effect, while a mixture containing about 30 per cent. of carbonic oxide, with 2 per cent. of hydrogen, gives a slower combustion and a better turning effect upon the crank, besides freedom from pre-ignition.

The demand for gas engines of large power is evidence that confidence in them is rapidly increasing, and given a sufficiently large installation, with or without by-product recovery plant, and producers or blast furnaces capable of giving a constant supply of gas varying but little in chemical composition, if the points discussed above have received due attention, there will be no possibility of its being replaced by its older rival, steam.

As bearing out many of the points indicated as the reason why producer gas has not given the satisfactory results expected, we have the testimony of Mr. John Pilling,† King's Lynn Electricity Works, who points out that the producer plant at King's Lynn required anthracite for fuel, costing 24s. 6d. per ton, and says that the comparative cost of anthracite and suitable steam coal at any particular locality where the power is required will determine whether the fuel costs would be lower if the power were produced by Dowson gas plant or by steam plant. He goes on to say that, generally, if the price of anthracite peas in any district were over £1 per ton, and steam coal could be secured at about 12s., it would be more economical to generate by steam.

* *Journal of the Iron and Steel Institute*, No. 11, 1901.

† Paper read before the Association of Municipal and County Engineers at King's Lynn by J. Pilling, M.I.E.E., borough electrical engineer.

Mr. Pilling gives the generating costs at King's Lynn as follows:—

GAS—YEAR ENDING 1901.

	£	s.	d.	Pence per unit.
Coal*	1,004	15	3	·98
Oil, waste, water, and stores ...	119	9	9	·12
Wages	636	10	11	·60
Repairs of works and plant ...	233	5	0	·26
	£1,994	0	11	1·96

STEAM—YEAR ENDING 1902.

Coal*	703	11	0	·59
Oil, waste, water, and stores ...	113	0	1	·09
Wages	521	6	5	·44
Repairs of works and plant ...	170	19	5	·14
	£1,508	16	11	1·26

* The cost of coal in 1901 was increased by £100, owing to the enhanced prices ruling.

The costs at Leyton for the last year, as recently published, during part of which time producer gas and gas engines were employed, were:—

	Pence per unit.
Coal	·679
Oil, waste, water, and stores	·055
Wages	·296
Repairs of works and plant	·326
	1·356

Mr. Pilling states his belief that there is a great future for gas driving in electric generating stations, but points out some of the qualifying considerations. He says that before much headway can be made in this direction, the gas must be produced from ordinary bituminous slack coal; the engines must be of large size; they must be direct-coupled to the generators, and must not be governed on the hit-and-miss principle, but rather by varying the quality of the charge at each admission.

All these points are fully realised by the best makers of large power gas engines, and none of them will be neglected by those firms who have had the opportunity of proving by experiment the serious obstacle that each of them offers to the satisfactory substitution of gas engines for steam engines.

SUPPLIER AND CONSUMER.

[FROM OUR LEGAL CORRESPONDENT.]

FROM the many queries which have recently been addressed to the editors of the ELECTRICAL REVIEW, it seems that the legal relations of supply authority and consumer are by no means free from difficulty.

It is true that a statement of the special responsibilities of each supply authority may be found in some provisional order or special Act; it is also true that the public Electric Lighting Acts are supposed to contain an exact statement of the law. Experience has shown, however, that provisional orders and Acts of Parliament are not always easily understood by lawyers. What wonder, therefore, that the Electric Lighting Acts should prove difficult to the consumer of electricity!

There is a further reason why the consumer often searches in vain through the Electric Lighting Acts. We refer to the fact that they are, for the most part, founded upon, if not exactly similar to, the enactments which regulate the supply of gas. Many general clauses which were framed to meet the needs of gas supply, and have been considered sufficient, have been inserted in the Electric Lighting Acts, to meet the requirements of electricity. In the result, existing electrical legislation is wholly inadequate to answer the numerous questions which frequently arise owing to the vagaries of electricity as an article of commerce.

In these circumstances, a few observations upon the law of supply undertaker and consumer, founded upon some of the queries recently addressed to us, may be found useful.

In the first place, there seems to be some doubt as to whether it is lawful for a company or private person to supply

electricity for gain, except under the auspices of a provisional order or special Act. A glance at the Electric Lighting Acts is sufficient to show that they are enabling only; that they confer special privileges upon those undertakers who supply electricity under a provisional order; but that they do not place any restriction upon the manufacture and supply of electricity. It remains to consider some of the disabilities under which the supply of electricity is carried on by those who do not obtain a provisional order. In the first place, they are to some extent under the control of the Board of Trade with regard to the use of overhead wires. Thus the Board of Trade may require that every overhead wire shall be continued and used only in accordance with such conditions and subject to such regulations for the protection of the public safety and of the electric lines and works of the Postmaster-General, and of other electric lines and works lawfully placed in any position and used for telegraphic communication, as the Board of Trade may prescribe. It is presumed, however, that the Board of Trade regulations are not of such a nature as to seriously interfere with the economical use of overhead wires.

More difficult, perhaps, are the relations of the unauthorised supply company with the local authority, inasmuch as the requirements of an undertaking of any magnitude necessitate that some highway or street shall be crossed by the company's mains.

Broadly speaking, the right to suspend wires above, or break up the surface of, the highway cannot be obtained without the consent or license of the highway authority. Further, within the confines of the administrative County of London, no overhead wires can be suspended in any place without the consent of the local authority. Seeing that the local authorities usually have the control of every highway and street in their district, and that they are often applicants for power to supply electricity themselves, it is often a matter of some difficulty for a private supply company to obtain the necessary license to cross a public thoroughfare. The case of the Finchley Electric Lighting Co., which came before the Courts in 1901, afforded evidence of the fact that the Finchley Urban District Council was quite prepared to use its powers as highway authority, to prevent a private company supplying electricity in the district, and this although the Council had not yet put its own provisional order into force.

With the above and one or two other unimportant exceptions, the liabilities of the supply company are very similar to those of statutory undertakers.

With regard to the relationship of an ordinary supply authority to its consumers, one of the most vexed questions appears to turn upon the price which the former is entitled to charge for energy. There is usually appended to each provisional order a schedule which gives the prices which the undertakers are empowered to demand; but there is nothing requiring them to supply energy which is to be used for motors at any special or lower rates. As a general rule, the maximum rate which the undertakers are entitled to ask is largely in excess of that which they can afford to demand of their customers. In consequence of this the rules framed by the undertakers to regulate their dealings with consumers are well within the four corners of their Act or provisional order. Assuming, therefore, that they undertake to supply energy on special terms if it is to be used for motors, they are within their rights, for the provisional order draws no distinction between energy which is supplied for lighting and energy supplied for power. It thus appears that in offering to supply energy at specially low rates for motive purposes, a supply authority is conferring a boon upon consumers.

In relation to the supply of electricity at such low rates, the question has arisen as to whether, assuming the rules form the basis of a contract between supplier and consumer, it is competent for a consumer to demand a supply for a motor-generator at the rates in force for an ordinary motor. It is assumed, for the purpose of discussing this question, that the rule forms part of a contract; otherwise, it could not bind the supplier.

In effect, of course, to run a motor-generator and use it for lighting purposes, is to evade payment of a higher price per unit. It thus appears that the use of energy for a motor-generator is, in one sense, a colourable evasion of a consumer's obligations to the undertakers, and this fact would obviously be taken into consideration in placing an interpretation upon any rule which recognises the supply of electricity for motors at special rates. Further, if a case upon the point were to come before the Court for discussion, the judge might ask how it is possible for an undertaker to supply energy for motors at cheaper rates; the reason being, of course, that motors are usually worked during the day, when the engines at the power station are for the most part relieved of their lighting load. It is clear that the use of a motor-generator for lighting purposes might thus upset the supply authority's calculations.

In the circumstances, we have always expressed the opinion that to use a motor-generator is a breach of a supply authority's rules, and that a consumer whose supply is cut off, or who is charged at lighting rates on this account, has no genuine cause for complaint.

REVIEWS.

The Generators of Electricity at the Paris Exhibition, 1900. By C. F. Guilbert. Paris: C. Naud.

This is a volume of some 750 pages, devoted to a detailed description of the direct and alternating current generators and converters exhibited at the Paris Exhibition of 1900. It also gives fairly complete accounts of the steam engines to which the majority of the generators were directly coupled. The work is very fully illustrated by means of line drawings and reproductions of photographs, and is well-arranged. As is usual with French publications of this nature, a paper cover only is provided, and this is a matter for regret in this case, as the work is well worthy of a better binding, and certainly needs it, on account of its size and character.

It is hardly possible to criticise M. Guilbert's work without criticising the actual machines which it deals with, which would be out of place in this review. But great praise is undoubtedly due to him for the exceedingly thorough way in which the subject has been treated, and for the pains that have evidently been taken to secure accuracy with regard to the constructional data and test figures put forward. The method adopted by the author in dealing with the large number and variety of machines in question, has been, firstly, to classify them, then to treat each machine, or group, separately; and, finally, to assemble the whole of the data relative to the construction and performance (of the generators) in tabular form, corresponding to the different classes.

The different headings in these tables (and the titles of the drawings, &c.) are printed in French, German, and English; all dimensions are in millimetres, and other quantities are in the metric system. It should be mentioned here that the work is divided into three distinct parts, dealing respectively with alternators, converters, and dynamos, each part being prefaced by a review of the machinery exhibited as a whole, the tendency of modern practice with regard to different points of construction and arrangement being indicated, while various general considerations are discussed.

It is unnecessary to say more with regard to the classification adopted for the various machines than that it meets all practical requirements; the machines exhibited belonged to every modern type, there being many different varieties, and no very scientific classification is possible. The division of these machines into main classes, according to the arrangement of their field systems, and then into sub-classes, according to the design of their pole-pieces and armatures, is probably as good an arrangement as could be devised.

The British visitor to the Exhibition itself left it with an unpleasant impression of the poor show made by his country, as far as engineering was concerned (not only with regard to the quantity, but more especially with regard to the quality of the exhibits), and the reader of M. Guilbert's work will undoubtedly be reminded of this; a critical examination of the British designs will regretfully convince him that they were by no means worthy of the country, which, when practice alone was the first consideration, led the way in engineering work. There can be little doubt

but that one reason for the excessive amount of foreign competition that has prevailed over here during the last two years, in connection with electrical matters, is that the Exhibition revealed to the world the backwardness of this country in these matters. Few can doubt that this is but a transient state of affairs, but it is always a difficult matter to recover so much lost ground.

The up-to-date designer will find much food for thought, and much useful information, in the author's work; the tables especially will be of value, as showing the effect (upon the weights and performance) of different arrangements, and of electrical and magnetic constants (for instance, of armature reaction and leakage), which differ widely, even in machines of the same type. He will notice with interest the (practical) disappearance of the inductor type of alternator and the claims of the latest type—the asynchronous generator—while the efforts made in the direction of compounding alternators (not only with regard to the amount of the load, but also with regard to its phase difference) will certainly appeal to him. And, finally, especially noteworthy is the increasing use of high saturations in the magnetic circuits of all classes of machinery, and the attempt of every designer to reduce the magnetic leakage of standard machines (both in the field system and in the armature) to the smallest possible amounts.

We have no hesitation in recommending M. Guilbert's valuable compilation to all those engineers (and students, also, for that matter) who are interested in the actual design and construction of dynamo-electric machinery.

Alternating Current Machines. By S. Sheldon and H. Mason. New York: Van Nostrand.

This is a well illustrated work of some 250 pages, dealing with alternating current problems and machinery, and is primarily intended as a text-book for use in technical schools; it is the companion volume to the same authors' text-book on "Direct Current Machines," and is written in much the same style.

The first four chapters deal with the properties of alternating currents, including the laws of the alternating current circuit. The treatment of these matters, which is mostly of a non-mathematical character, is clear, and sufficiently detailed—some of the graphical constructions are excellent. It would have been an advantage, however, if the theory of the measurement of the energy and power in single and polyphase circuits had been given here, partly as a preparation for certain of the experimental exercises given in the last part of the book, but also because this important matter is, as a rule, inadequately dealt with by most writers, and there is in consequence a good deal of misconception on the subject.

The next four chapters deal with single and polyphase alternators, motors, transformers, and converters, and with various practical matters connected with their installation and operation. All these chapters (forming the main part of the book) are inadequate and disappointing; the treatment is scrappy, and consists for the most part of what are really abstracts from the trade bulletins of the large American manufacturing companies, with definitions tacked on of the terms, &c., used therein. The question of armature windings of alternators is dismissed in two pages, while such important matters as armature reaction and leakage of alternators, parallel running, &c., are dealt with in short paragraphs. The few lines of explanation devoted to the principles of working of the induction motor are wholly insufficient, and even misleading, while the authors' treatment of the elements of transformer design is useless for practical purposes. We consider, in fact, that the sort of knowledge a student is likely to gain from a perusal of these chapters (which cover the most important questions in connection with the subject) is likely to do him more harm than good, while the engineer wishing to become acquainted with the subject would hardly have patience to read the authors' superficial treatment of the matters dealt with.

Chapter IX., dealing with power transmission, is somewhat better, but is much too short; no examples of practical calculations are given for various transmission systems, and for this reason, as far as the student is concerned, a clear impression is not given of the subject.

The last chapter (Chapter X.), considered from the scholastic point of view, is also good; it clearly describes a number of experimental tests and exercises quite suited, for the most part, for students taking an elementary laboratory course in alternating current work; it is, however, a waste of time for a student to carry out such experiments as the measurement of power by means of the three-voltmeter or three-ammeter methods, which are nowadays of academical interest only, while, again, the measurement of the mutual inductance of transformer coils can hardly lead to any practical result.

The plant and apparatus described in this book are wholly American, while a good many terms, more or less unfamiliar to students on this side, occur throughout the book; for instance, "synchronous reactance," the "admittance" and "susceptance" of an alternating current circuit, the number of "Maxwells," &c. The authors' work may find a limited use in certain of our technical educational institutions, but, on the whole, it certainly cannot be said to fulfil the objects for which it was written in a proper and adequate manner

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THE SMALL CONSUMER.

[COMMUNICATED.]

In view of the present strenuous competition of gas and oil, the small consumer becomes a factor in the economy of an electric lighting undertaking that those in authority cannot afford to neglect. It is only within the last few years that this fact has become to any extent appreciated, and although various concessions have been generally made to enable the man of small means to enjoy the advantages of electric light in his place of business or home, the progress in this direction can scarcely be deemed satisfactory. No doubt the primary trouble lies in the initial cost of wiring and fittings, and in view of all that has recently been written upon this matter, further reference to it here is unnecessary. Many schemes have been proposed to get round this difficulty, and it now only remains to be seen if the men who devote their time to the study of the problem of cheap and effective wiring will be able to show us satisfactory results from the practical working of their schemes. What concerns the central station engineer in the present state of things is, how, with the initial trouble of a comparatively heavy outlay of capital on the part of the consumer, he can popularise his wares and forward Sir William Preece's Utopian idea of making electricity the "poor man's light."

Free wiring is undoubtedly in a measure a solution of the difficulty, but its possible good effects are often marred by the desire of the supply authority to obtain a greater return upon its capital outlay on wiring than the consumer is willing to pay. To start with, all free wiring schemes should be on the hire purchase system; not on the perpetual rent system, unless that rent can be made very much lower than is usual at present.

Nothing is so apt to discourage a prospective consumer as to be told that he will always (until he buys his wiring outright) have to pay, say, 1d. or 1½d. per unit more for his current than his next door neighbour, who has possibly wired his premises himself. In the majority of cases, when considering the matter he will work out what that extra charge means in time. He will, no doubt, be told how many units he will probably consume in a year, and he is certain to have some idea of what wiring would cost. It is then only a question of putting two and two together and finding out approximately what profit the supply authority proposes to make on his wiring. Cases akin to this have occurred in the writer's experience, and the result has generally been that free wiring negotiations have fallen through. The system of charging a rental on each 8-c.p. lamp installed, although obviously fairer than the above, often suffers from the same objection; the rental in many cases is preposterously high, and tends more to throttle the scheme than to forward it.

It is, of course, only fair that there should be a certain amount of return on the capital outlay, but considering that the amount expended in free wiring is in most cases so

extremely insignificant in proportion to the total outlay on an electric lighting undertaking, surely this return should be reduced as low as possible with the view of popularising the supply and introducing it into quarters where mains may have had to be laid, and yet where they will never be reproductive without free wiring.

While the small consumer is often a very paying one from the point of view of long-hour use of his lights, he is frequently unpopular with the central station engineer, owing to the fact that his total service costs will amount to very nearly as much as those of an installation of 20 times the number of lights. Services to even the smallest consumer cannot, as a rule, be put in for much less than £5, including fittings and instruments, and until this state of affairs is remedied and the cost approximated more to that of a gas service, he cannot be as remunerative as we could wish. With the present systems of mains, practically no further economy can be effected in the actual laying and jointing of the service cable. If the costs are to be reduced it can only be done by aid of cheaper meters and fittings.

It is an astonishing fact that many engineers of direct current stations are still installing more or less inaccurate and wasteful motor-meters of 3 to 5-ampere capacity, costing anything from 50s. upwards, when a 1-ampere meter of the electrolytic type, costing 25s. to 30s., would be just as effectual, have a longer life, and undoubtedly be more accurate.

One hears that they are "messy," or "contain dangerous chemicals," or "cause too much of a drop," but when gone into practically, these objections will disappear, or, at any rate, become considerably less. For instance, there is nothing "messy" in the operation of refilling a Bastian meter, as now performed; the chemicals only consist of a very weak solution of sulphuric acid that is quite innocuous, and the "voltage drop" is practically negligible in these days of high voltages. Compare a voltage drop of 2½ volts, which only goes on while current is flowing through the meter, with the constant 24-hours' loss that is incurred in the shunt of an ordinary wattmeter. Few people have any idea of how much this latter amounts to in a year.

More or less, the same may be urged in favour of the Reason or Schattner meters; for small powers, they are infinitely superior to any motor-meter in prime cost and permanent accuracy.

This question of cheap meters affects a matter of very great importance, viz., meter rents. If there is anything the small consumer objects to, it is to have to pay 2s. or 2s. 6d. per quarter for his meter. It is no good explaining to him that electricity meters and services cost much more than their equivalent in gas supply, as that does not directly interest *him*. His point is that he has only paid, say, 6d. a quarter for having his gas metered, and he does not see why he should pay 2s. 6d. for his electricity. This is a point that might apparently be reconsidered by many supply companies and local authorities.

Without going so far as to totally abolish meter rents, and so create a falling off in receipts that many undertakings could ill afford, is it not possible to get somewhere nearer the gas standard, and reduce meter rents to an average of, say, 1s. 6d. at the most? In the case of meters costing £10 or more, there is some justice in the existing high rates charged in many districts; but surely if a meter only costs one-fifth of this, 2s. or 2s. 6d. per quarter is an overcharge, and one of which the consumer is perfectly well aware, the local gas company having generally acted as mentor in such cases. There can be no doubt that these comparatively high meter rents deter many small householders from installing electric light, owing to the fact that this item would often make up a considerable percentage of the quarter's account. If meters were rented in proportion to their size, as is, unfortunately, not the general practice, a fruitful source of dissatisfaction would be eliminated, as it is only human nature to object to being charged proportionately more for the same article than one's neighbour.

An important factor in securing the small householder as a consumer is the slot meter. The gas companies recognised this long ago, with results that are well known. Many electricity slot meters have been devised, and certainly thousands are now in use, but for reasons, probably, of unreliability, they have never come to the fore as much as might be desired. This is a matter to be greatly regretted, as a thoroughly trustworthy slot meter, in conjunction with free wiring, seems to be at present the best bait wherewith to catch the small fry. The average small shopkeeper, for instance, does a strictly cash trade, and consequently, through lack of capital or reserve, prefers to pay as he goes, thus keeping a constant eye upon his expenditure and avoiding, at the end of the quarter, the necessity of footing a bill, which may, for the time being, somewhat cripple his immediate resources. As the gas companies have found, there is quite a large class who, if they cannot pay for their illuminant on the ready-money principle, prefer to use oil, even though it is expensive and troublesome. This points out the absolute necessity of slot meters in truly popularising the electric light. In almost everything it pays to "play to the gallery," and if electric light is going to compete on a level footing with gas, the needs and wishes of even the smallest householders must be considered. *Apropos* of this and slot meters, what is wanted at the present time is a meter with a separate coin receptacle or actuating device, which can be fixed, say, in a shop or hall, the meter itself remaining in a cellar, or the usual ungetatable place.

Many people have an objection to slot meters because they often entail a somewhat risky journey in the dark, and a great deal of fumbling about to find the slot. It may be urged that as the main leads would have to be brought up to the attachment, the meter itself might as well be put in an accessible place; but it must be remembered that while no meters are particularly artistic, and most people would object to their presence in a sitting room or hall, a small and suitably designed coin receptacle would not suffer from the same defect.

TUNBRIDGE WELLS TELEPHONES.

The Postmaster-General has given a decision on the Tunbridge Wells case which accords with the anticipations expressed in our issue of November 28th. Replying to a question from Mr. Boscawen, a member for the district, Mr. Austen Chamberlain stated in the House of Commons on the 11th inst., that, after carefully considering the important question of principle involved in the application of the Corporation for the transfer of the undertaking, he could only give his consent to the sale on certain conditions which are necessary for the maintenance of the policy approved by Parliament in the Telegraph Act, 1899.

The conditions of the Act which were to be exercised to appease Parliament were: (1) a limitation of rates; (2) no preferential charges or conditions, and no compulsory wayleave facilities to be claimed as a condition of service, except for the connection of a subscriber's own premises; (3) all plant to be approved by Postmaster-General; (4) subscribers in other areas to Post Office exchanges, and of their other licensees, besides the National Telephone Co., to have free intercommunication over trunk wires, without the imposition of terminal fees to the Corporation system, and subscribers to a Post Office system in the same area to have the right of intercommunication on terms to be settled by arbitration, if necessary.

The company were informed of these conditions, together with the further important one, that the duration of the existing licenses in the area must be curtailed, so as to expire in 1911. The Corporation license provided on its expiry for the purchase of useful plant by the Post Office on "Tramway Terms." This provision it was proposed to extend to the whole of the National plant within the area. The National Co. accepted the terms, notwithstanding that they will incur, under the agreement, considerable pecuniary obligations, extending beyond 1911.

The Postmaster-General considers that the decision arrived at "secures all the advantages contemplated by Parliament in sanctioning municipal competition as affecting both existing and future subscribers, and the development of the general telephone system."

The Tunbridge Wells Corporation are to be congratulated on getting out of their difficulty so advantageously, and it is to be hoped that other Corporations will not be encouraged by this result to lightly embark on similar enterprises.

OUR LEGAL QUERY COLUMN.

[Questions addressed to the Editors for insertion in this column should be written on one side of the paper. Free use of fictitious names, &c. may be made. Answers are furnished by a duly qualified lawyer, but the Editors cannot undertake to be responsible for the accuracy of the views which he may express.]

"Dynamo" writes:—"I note your reply to "Electric" in last week's Review. I am myself about to put down a plant under similar conditions, but do not wish to cross any thoroughfare. If, as you say, "Electric" is at liberty to supply to customers in the town without obtaining a provisional order, what is the necessity in any case for obtaining one? Also, are there any Board of Trade restrictions to comply with?

*** If "Dynamo" will read an article entitled "Supplier and Consumer," which is published elsewhere in this issue, he will probably find a sufficient answer to his question. There is no actual necessity to obtain in any case a provisional order; but there is a virtual necessity if the promoters are desirous of obtaining Parliamentary power to disturb streets, erect overhead wires and enforce penalties upon consumers who decline to observe the statutory rules.

METROPOLITAN ELECTRIC SUPPLY CO.'S ARBITRATION.

A further sitting of the tribunal appointed to arbitrate as to the purchase price to be paid by the Marylebone Borough Council for a portion of the undertaking of the Metropolitan Electric Supply Co. was held on Friday of last week at the Law Courts. The arbitrator is Mr. C. A. Russell, K.C., with whom are sitting as assessors, Mr. Robt. Vigers and Mr. W. C. Ryde.

After a short re-examination of Mr. Arthur Wright, Mr. Fletcher Moulton, K.C., commenced to sum up the case on behalf of the Borough Council. He said it was not until within two or three days ago that he was aware that the duty would have been cast upon him of replying for the Borough Council, as he anticipated having had the pleasure of hearing Sir Edward Clarke do it. As to their case, he felt that it was of great importance that the case should be put consecutively and logically before the tribunal, and that as far as possible the effect of the argument should be traced in the shape of figures What he was trying to assist the tribunal upon, was in assessing an amount. It was not a finding on the rights of the parties, but a finding on the amount of the payment that was to be made for the purchase of the undertaking. The task before them was a very novel one, and in many respects a very difficult one, the difficulty arising to no inconsiderable extent from the novelty. It was not only the first instance that he knew of of such a purchase, but the subject of the purchase was in many respects widely different from the other companies that had been purchased by an arbitration value. Before he went into details it was necessary to lay the foundation for the valuation in general principles. The main outline of the question was the purchase of an electric lighting undertaking with the ordinary powers limited and conditioned by special arrangements. Both those facts would, if his case was right, profoundly affect the valuation. His learned friends had, by their questions, seemed to indicate that that was what they termed the purchase of a statutory company, as if that had any peculiar consequences on the valuation. He submitted that there was no such thing as a class of statutory companies having a special type of valuation. Certain companies might have, or even be obliged to have, statutory powers, but in valuing a company the question of their having statutory powers was not that which dominated the valuation—it was the question of the nature of the company created by those statutory powers. The distinction was between an electric lighting company and others, not between a statutory company and others. There was one point of a perfectly general character that he wished to premise, and that was that this was clearly a question of purchase by agreement; it was a purchase, of course, under the powers of an Act, and the special terms of that Act were what would guide them absolutely throughout the whole of their deliberations. A purchase by agreement signified that they were to pay the company the value of what they were selling. It was a question between a willing buyer and a willing seller, and there was no question of compulsion in the matter at all; and it was in that purchase that they got the best definition of "value." If there was an eager buyer and an unwilling seller they exaggerated the price, and with an eager seller and an unwilling buyer they got a reduced estimate of the price. He wished to direct the attention of the tribunal to the nature of an electric lighting company, because he thought that profoundly influenced the valuation. An electric lighting company had most exceptional duties and most exceptional obligations. The fact that it had to deal with force and not matter, strangely enough influenced largely its financial position, because practically an electric lighting company was not only compelled to do all that the public required of it in the way of quantity of supply, but it was obliged to do that every moment without in any way being able to prepare for the demand. That peculiarity of electric lighting companies had the very greatest effect on the commercial value of such an undertaking. For it meant that step by step with the increase of possible demand there must be a continuous outlay on capital. They could not provide, as they could in water or gas, for a momentary increase of demand, and if their profits were to grow, if electric lighting was going to spread during the period of the concession, they had to contemplate serious additions to capital all the way through, so that when a company or a person took the obligation of an electric lighting order, they knew that they were undertaking throughout their concession to continue to make large capital additions, which were invested in the form of plant, and of working plant—not in plant that lasted for ever, like the installations of the water companies, or which had a very, very long life, like the plant of gas companies, but working plant which was subject to the short life of machinery, and which was in all cases moving machinery driven by steam. That was a very serious obligation, and it became a more and more serious obligation when they coupled it with the fact that the concession was terminable. Water companies and gas companies in all cases had had perpetual concessions. The consequence was, that the capital that they put down they knew they would have the enjoyment of, but in the case of electric lighting companies they had to put down plant of which they could only hope to have a year or two, or a few years' use. That made a distinction between the capital obligations of electric lighting companies and those of water companies and of gas companies, which was of the very greatest importance, and had the greatest influence on their commercial value. He quite agreed that there were other companies with terminable concessions—such as tramway companies, but in the case of a tramway company the main outlay was at the commencement. Electric lighting companies were bought up under the 1888 Act, and those terms of purchase were very different from those relating to tramway undertakings. There were words in the Act which were comforting to the companies, but there were also words which were very much the reverse. In the first place, it was to be the "fair market value at the time of the purchase." It was not to be "as a going concern," it was simply to be the "fair market value," subject to a consideration which he would deal with later on. Then they were to have due regard to the nature of the plant—that was to say, whether it was obsolete or whether it was plant that was new and of good quality; to the nature and conditions of such building works, materials and plant, and to the state of repair, and then he came to something which was no doubt a concession to the companies—"to the circumstance that they are in such a position as to be ready for immediate working." He had no doubt that meant that they should consider that time would be taken in erecting those works, and that during that time there would be, of course, a certain amount of outlay which they were not getting a return upon until they could start the undertaking. Then came these words—"and to the suitability of the same for the purposes of the undertaking," so he took it that they were able to criticise when they were estimating the final purchase price on a statutory purchase, both the condition and the nature of the plant, buildings, &c., and whether or not they were suitable for the purpose of the undertaking, and at best they had only to give a fair market value when they had taken into consideration all those things. It was very important to notice that what they had to consider was its readiness for immediate working, and, of course, if the nature of the installation was such that it was not ready for immediate working, all claim to consideration under that head must necessarily go.

Mr. Ryde said he would like a little more explanation with regard to the question of a company being ready for immediate working. He would put some hypothetical figures to illustrate his meaning. Suppose a set of plant cost £100,000. He had a company that resolved to-day to put in that plant, which would take a year to put in; at the end of a year, assuming all the other conditions were complied with, it was suitable and in good repair, and at the end of the year it would be ready to work, and do exactly what was wanted. At the end of six months the local authority gave him notice to purchase *inter alia* that plant. How should they address themselves to the question, How much was to be given to him at the end of 12 months for the added value at the moment the company wanted to take it over?

Mr. Moulton said he would deal with the point when he came to the figures. Continuing his address, he said that the terms of the clause he had read did not apply directly in this case, because the Borough Council was buying the company at its value, but in considering its value they had to consider that it was a company with a terminable life coupled with a solatium. There was no doubt that if the company could only be bought up on terms of paying its value as a going concern, it would be enormously more valuable; but it was a company whose concession terminated at the end of 21 years, and they bought it, therefore, without any allowance for goodwill or for any future profits. The consequence was, it was much less valuable. On the other hand, some solatium was given; set against that there was distinct direction that they were not to buy at the new valuation of plant, but to buy considering the nature and then conditions of the plant. Those were the terms on which its life would be put an end to. There was one other point he wanted particularly to insist on, and that was, that the status of electric lighting companies was distinctly worse than that of any statutable company that supplied the wants of the public, in one grave respect, and that was that the general statutes regulating their existence were passed at a time

when the public was exceedingly jealous of monopolies, and the legislation contemplated in the most practical way, the introduction of competition. As a matter of fact, there was competition now in many areas, so that it was a thing which was present to the minds of the public, and it must have a most extraordinary effect on the status of electric lighting companies. In the case of the Metropolitan Co., they would see that competition was staved off for two or three years, always by the assistance of local authority, and he did not think he was asking them to go too far when he suggested that the keeping off of competition would have been exceedingly risky and difficult, if the company had not come to terms with the local authority, by which they were to be bought up by them. He submitted, therefore, that the tribunal must have in their minds that important qualification of the security of the company's concession—that it was liable to have direct competition introduced. Turning to the agreement of October 1st, 1889, by which the Vestry consented to the granting and confirming of the company's order, the learned counsel went at some length into the contractual relations which governed the company in its dealings with the Borough Council, and said he should ask the tribunal to act upon the contract, as it embodied the conditions on which the company came into existence.—Adjourned.

LIQUID FUEL.

On Thursday, December 11th, Prof. V. Lewes delivered the first of two lectures on liquid fuel, which he is giving at the Petroleum Institute. He commenced by giving a brief *résumé* of fuels generally, and pointed out that well dried wood, such as had been 20 years acting as a beam in a cottage kitchen, would show 20 per cent. of water. He then referred to the carboniferous epoch of the world, when the atmosphere was richer in carbonic acid gas than it is to-day, and vegetation was more luxurious, so that plants which now grow but a few inches, were then 70 ft. high. On this point we might observe that probably warmth had its effect as well as superabundant carbon dioxide. Probably by far the larger part of the carbon in the world is locked up in the huge masses of the chalk, and of the carboniferous limestones and other calcareous rocks. The proportion of pure carbon in dry chalk and limestone is 12 per cent. Now the carboniferous limestone attains a thickness of 4,000 ft., which is the equivalent of a seam of coal 480 ft. thick. The chalk again, which has a thickness varying up to 1,200 ft., represents a coal seam 144 ft. thick. In the atmosphere itself there are some 580 thousand million tons of carbon, which about represents man's fuel consumption in 1,000 years, so that, apart from fresh production of coal, it would be well into the thirtieth century before the atmosphere contained 8 parts in 10,000 of CO_2. Prof. Lewes complained of the prohibitory flash point for liquid fuel, 200° F. by Lloyds and 270° F. in the Naval service. Germany allowed as low as 150°. He thought that such high flash oils were far too viscid, and, of course, being so they require too much heating up by steam coils before they will atomise freely.

On the question of calorific value, the fact that in liquid fuel the carbon is liquid and the hydrogen is liquid, whereas in coal both are solid, was referred to as helping the calorific power of liquid fuel, but no one knows what the latent heat of liquefaction amounts to. This view of fuel action was put forward by Mr. W. H. Booth, in the Electrical Review of August 30th, 1901, wherein it was pointed out that in burning bituminous coal regard must be had to the effects of heat absorption in vaporising the solid hydro-carbons on the grate. It is usually accepted that the heat of *vaporisation* of carbon is the difference between the heat produced by the first and second oxidations of carbon to CO and CO_2 respectively.

The method of calculating heat latency in this way has not, however, the support of M. Berthelot, who hints that the latent heat of carbon vapour is greater than the above amount by an amount which he terms ϵ. But there is no information of any sort as to the latent heat of liquefaction of carbon or hydrogen.

The calculation of calorific capacities by formula was criticised. Thus methane or CH_4, calculated by the usual Favre and Silbermann formula, comes out at 14,660. Yet, though a gas, it only gives 13,384. This is because, when it is formed, an exothermic action takes place, and most of the hydro-carbons develop heat when formed and give out so much the less when burned—acetylene being a well-known exception, or endothermic.

The lecturer seemed to approve of Wright's formula for calculating calorific capacities, viz.,

$$8{,}080\ C + 28{,}780\ (H - \tfrac{O}{8}) - 600\ H_2O,$$

where H_2O is the hygroscopic ratio.

The practical evaporation effected by petroleum was given as 16 lbs. against 9 by coal. The ratio 1·77, together with the saving in labour, the saving in storage, the economy of "coaling ship," and the economy of cargo space, liquid fuel being carried in the ballast tanks, enabled liquid fuel to be used at 50s. per ton, as against coal at 25s., which was less than coal cost in very many of the world's ports. A further advantage with ships of war was their greater radius of action. Referring to the formation of petroleum, the lecturer pointed out that it consisted chiefly of two series of hydro-carbons in varying proportions and of the formula $C_n\ H_{2n+2}$, these being the hydrogen-satisfied compounds, and $C_n\ H_{2n}$, which still lack atoms of hydrogen, and are, therefore, more easily affected by other agents than the members of the first series.

Considering how soft are even the solid hydro-carbons, may it not, we venture to ask, be assumed that coal belongs to a series still further removed from the gaseous end of the series?—For coal is a hard-enough solid, only split up by heat into solid carbon and gaseous and semi-viscous hydro-carbons.

LEGAL.

Gilchrist *v.* Hereford Lavey and Others.

Electrical Engineer's Libel Case.

Mr. Justice Ridley, sitting with a common jury in the King's Bench Division on Friday last, concluded the hearing of an action for libel brought by Gavin Knot Gilchrist, electrical engineer, Deansgate, Manchester, and Garden Street, St. Ann's, Lancashire, against Hereford Lavey & Chapman, carrying on business at 9, Victoria Street, London. The alleged libel of which plaintiff complained was contained in a telegram sent by Mr. Hereford Lavey to a Mrs. Kerr, a lady of considerable means, who was assisting plaintiff in business. The telegram was in these words:—"Unless we receive a cheque for at least £100 per return, we shall be reluctantly compelled to file a bankruptcy petition against Gavin Gilchrist to-morrow." Plaintiff's case was that about December last year Mr. Hereford Lavey persuaded him to enter into an arrangement, by which he was to act for the sale of certain electric lighting goods for the Electric Lighting Boards (British Manufacturing) Co., Ltd. By an agreement entered into, plaintiff was to purchase a quantity of goods amounting to £6,000 from Mr. Lavey, with the view of carrying on the agency. Some two or three months afterwards it turned out that Mr. Lavey had no authority to appoint Mr. Gilchrist his agent, and the result was that the agency was terminated. On learning that Mr. Gilchrist had visited London with the object of instituting proceedings against him for breach of contract, and to recover money paid to defendants in respect of goods, Mr. Lavey, it was alleged, sent the telegram complained of to Mrs. Kerr, with the object of doing him harm in the eyes of his relatives. Defendants did not admit publication of the libel, and contended that the words used in the telegram were incapable of the meaning alleged by plaintiff. It was further pleaded for the defence that if the publication was made, it was privileged.

Mr. Lusk, K.C., and Mr. Neilson appeared for the plaintiff, and Mr. Simons for the defendants.

Plaintiff, in his evidence, denied that there was any justification for the statement in the telegram.

After hearing defendants' evidence,

The jury returned a verdict for plaintiff for £75 damages.

Judgment was entered accordingly.

Westminster Electric Supply Corporation, Ltd., *v.* the Improved Wood Pavement Co., Ltd.

In the King's Bench Division of the High Court of Justice on Thursday, December 11th, before Mr. Justice Wright, sitting without a jury, the action of the Westminster Electric Supply Corporation, Ltd., *v.* the Improved Wood Pavement Co., Ltd., came on for hearing. Plaintiff corporation in their statement of claim set forth that they were a company with Parliamentary powers for the supply of electric energy in the City of Westminster. Such energy was distributed to the plaintiffs' customers by means, *inter alia*, of insulated copper mains laid beneath the roadway in the districts supplied by the plaintiffs. These mains were composed of a copper core, surrounded by alternate layers of jute and lead, the whole being enclosed in a lead casing to protect the mains from the action of water. About the beginning of October, 1900, the defendants were engaged in laying wood pavement on a portion of the roadway in Berkeley Square, under which the plaintiffs' mains were laid. Through the wilful negligence and careless and improper conduct of the defendants in laying the pavement, plaintiffs said they had suffered damage. They alleged that the defendants by their workmen, although warned by the plaintiffs' agents of the presence of their mains, neglected to use reasonable and proper care, the result of which was that one of the plaintiffs' mains was damaged by a pick or wedge being driven through the covering of it. The damage complained of was caused by the plaintiffs' main becoming exposed to the moisture of the surrounding earth, and becoming rotten and losing its insulating qualities. The electric current in the main was thus enabled to escape, and the lead covering and the jute insulation of the adjacent main was thereby destroyed and the main rendered useless, thus stopping the supply of the current to the plaintiffs' customers. Plaintiffs, as a consequence, were put to the trouble and expense of replacing the main, and for this they claimed damages. The defendants denied the alleged carelessness and negligence, and also the alleged damage to the main.

Mr. Horace Avory, K.C., and Mr. Kennedy, were counsel for the plaintiff company, and Mr. Spencer Bower for the defendants.

Mr. Avory, in opening the case, briefly detailed the facts as given above, and said his case was that the damage was caused by the carelessness of the defendants' workmen by driving wedges in order to break up the wood pavement. His clients, in consequence, had had to lay a considerable length of new cable, and had been put to great expense and trouble for which they claimed damages.

A number of electrical engineers and inspectors of the plaintiff company were called, and gave evidence in support of their contention that the damage to the main was caused by the carelessness of the defendants' workmen.

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Mr. Bray, on Friday, said his contention was that the damage was not caused by the defendants' men, and that if it was, it was not caused by negligence or carelessness. He also called electrical experts, engineers, inspectors, &c., who gave technical evidence in support of his case.

His Lordship, in giving judgment, pointed out that there had been no cross-examination by plaintiffs' counsel of the defendants' witnesses as to the specific dates on which the damage was alleged to have been caused. It appeared to him, on the evidence generally, that there was no cause for action against the defendants. It was not to be wondered at, however, that the plaintiffs thought they had a case against the defendants because of the coincidence of the time when the work was done by the defendants, and the damage to the main. There must be judgment for the defendants with costs.

Hawkes v. Leyton Urban District Council.

In the Chancery Division of the High Court of Justice on Friday last, before Mr. Justice Buckley, Mr. H. Terrell, K.C., on behalf of the Leyton Urban District Council, moved that an order of April 30th last year, made by his Lordship, whereby a writ of sequestration was directed to issue against the Council, might be discharged, or, alternatively, that the operation of the order might be directed to be stayed until further order. He stated that in February, 1900, his Lordship gave judgment against the Council restraining them, their servants and agents, from causing a nuisance by employing gas engines in connection with their electric supply works at Leyton. That order had been stayed until December 17th of this year, on the defendant Council undertaking to make certain alterations, and to cease altogether to use their gas plant. This had been done. The gas engines had not been worked since, and steam engines had now been erected of sufficient power to supply the whole of the requirements.

Mr. A'Beckett Tyrrell, for the plaintiff, said he understood the gas plant had been entirely disconnected, and would never be used again. Under these circumstances he did not oppose the application, provided costs, as between solicitor and client, were paid by defendants.

His Lordship accordingly discharged the order, and directed defendants to pay the costs.

Ferranti v. The British Thomson-Houston Co., Ltd.

In the Court of Appeal, composed of Lords Justices Vaughan-Williams, Stirling, and Cozens-Hardy on Monday, a considered judgment was delivered in this case on the appeal of the plaintiff, Mr. S. Z. de Ferranti, electrical engineer, from a decision of Mr. Justice Swinfen Eady in the Chancery Division, giving judgment for the defendants.

Lord Justice Stirling read the judgment of the Court. He said that the plaintiff in this case sued the defendants for infringement of letters patent granted to him in 1887 for improvements in electricity meters. Previously to the year 1887 the plaintiff had invented an electrical meter in which the current to be measured was made to pass through a bath of mercury in a magnetic field, so disposed that the mercury was put into a continuous rotary movement by the passing of current, the movement of the mercury being recorded by means of a float or disc with recording mechanism. That meter was designed for use with a continuous current, and with a solid magnet made of cast-iron; the residual magnetism of the cast-iron assisted in causing rotation of the mercury, and so enabled the meter to start with only a small number of lamps in use. His Lordship then referred to what the plaintiff, in his patent of 1887, had done to adapt the meter for use with an alternating current. It was necessary to employ pole-pieces which did not retain residual magnetism, and laminated iron was substituted for solid cast-iron magnets. In order to effect the object previously attained by the residual magnetism, and so enable the meter to start and register correctly with a low load, the plaintiff, in 1887, achieved the result by employing an additional coil of an insulated conductor, which would act as an electro-magnet, and thus compensate for the loss of residual magnetism arising from the abandonment of solid cast-iron magnets. This invention formed the subject of the plaintiff's letters patent of 1887. His Lordship having explained what the defendants had done, and of which the plaintiff complained as being an infringement of his patent, said that the whole point in the case turned on the construction and meaning of the words used by the plaintiff in his complete specification, viz., "The current passed through these additional coils forms no part of the circuit the current through which is to be measured, but is a branch circuit direct from the main conductor from the dynamo to earth, or to the return conductor." This Court thought that the direction in these words as applied to meters of the kind invented by the plaintiff was intended to mean that the branch circuit should pass from the main conductor to earth, or to the return conductor, without passing through the mercury bath. It appeared to this Court that the plaintiff regarded this direction as essential to the working of his meter. There was nothing to show that it had ever occurred to him to consider whether the current through the additional coil might be admitted into the bath under any conditions, and if so, what they were; there was certainly no suggestion of the kind to be found in the plaintiff's specification. If the statical friction between the mercury and the bath could be overcome by the use of a coil, the current through which did pass through the bath, and the meter could thereby be made to start and work accurately, it seemed to this Court that such user (not being colourable merely) would not fall within the scope of the plaintiff's patent. The defendants did not use a meter in which the current to be measured was made to pass through a bath of mercury. But, notwithstanding this, defendants might be guilty of infringement, for plaintiff stated in his specification that "the same improvement was applicable to all motor meters, that is, motor meters in which the movement is obtained from the current to be measured." Even assuming that the defendants' meter was a motor meter of the kind referred to, what was it that the defendants had done? In the defendants' meter, the current to be measured passed through fixed coils, and acted on a branch or shunt current passing from the main to the return conductor through a rotating coil, whose revolutions were recorded. In this form of meter there was statical friction just as in the plaintiff's form; and, to overcome it, the defendants used an additional coil, placed not in the current to be measured, but in the branch current just mentioned. It would be observed, however, that in this arrangement there arose a difficulty precisely analogous to that which was met when, in a meter of the kind invented by the plaintiff, the current through the additional coils was permitted to pass through the mercury bath; for the current in the coils added to the defendants' meter, acted upon the current passing through the rotating coil whose revolutions were recorded, and might produce motion in it, though no current might be passing to any lamps. In fact, it was stated by Mr. Dugald Clark that this arrangement of the defendants' was electrically equivalent to the use in connection with a mercury meter of a current which did not enter the additional coils until after it had passed through the mercury bath. Nothing had been done by the plaintiff's specification towards the removal of this difficulty; but the defendants had found the way of getting over it. This appeared to consist in the delicate adjustment of the additional coil in such a way that the force exerted by it on the revolving coil was insufficient by itself to overcome the friction, but was sufficient to start the meter when combined with the force produced by a single lamp current. If the force exerted by the additional coil were more than sufficient to overcome the friction, then the result would be that the revolving coil would begin to rotate and the customer would be charged with current not used in the production of light. On the other hand, if the force exerted by the additional coil, together with that produced by the one-lamp current, were insufficient to start the meter, the customer would not be charged with the current he was using. The Court, in these circumstances, thought that Mr. Justice Swinfen Eady was right in deciding that the defendants had not infringed, and consequently the appeal failed, and would be dismissed with costs. The learned Judge had decided in favour of the defendants on a further ground, viz., that the plaintiff's invention was limited to current meters as distinguished from energy meters, and that the defendants' meter belonged to the latter class. They were not satisfied that this ground of decision could be supported, for though defendants' meter was an energy meter it was, in fact, used for measuring current, and could only be so used by reason of the pressure in the shunt current being kept practically constant. It was unnecessary, however, to express a decided opinion on this point.

The appeal was accordingly dismissed, with costs.

River Plate Electric Light and Traction Co., Ltd.

On Tuesday, in the Chancery Division, Mr. Justice Byrne had again before him the petition of the River Plate Electric Light and Traction Co, Ltd., and its liquidator, for the Court's sanction to the scheme of arrangement between the company and its unsecured creditors, by which the latter were to receive fully-paid shares in the new company. His Lordship last week made an order directing a meeting of the contributories to be held on Monday last. The order was drawn up, and it directed that notice of the meeting should be sent to each of the contributories; it also ordered separate meetings of the preference and ordinary shareholders to be held, and notice given to such shareholders. Notice had been given to all save four, who were resident abroad, and with regard to those four the articles provided that they should not be entitled to notice of the meeting unless they left an address in the United Kingdom at which they could be served, and this they had not done. His Lordship sanctioned the scheme as proposed.

CORRESPONDENCE.

Runaway Cars.

I like the appearance of cars with the Bellamy extended roof; but the Bellamy latest addition, the new roof canopy, in my opinion, gives cars an ungainly, top-heavy, and unattractive appearance.

I have read with interest the letters which have appeared in recent numbers of the Review, also your leader on the subject of brakes, and as manager of an electric tramway, I am anxious to avoid those ugly accidents caused by runaway cars, which have been too numerous just recently. The injurious effects of these accidents are far-reaching. The travelling public do not readily forget them, and in towns far away from those where the accidents happened the

occupants of cars, especially when ascending or descending steep grades, are quickly alarmed should the slightest irregularity in running manifest itself.

I have no practical experience of the working on steep grades of cars of the Bellamy extended roof type, and it would, I think, be interesting to your readers to hear what practical managers say as to whether there is greater risk of this type of car "getting away" on steep grades. Are cars of the Bellamy extended-roof type in use at Devonport, Chatham, Newcastle, and Huddersfield, where runaway car accidents have lately occurred ?

In my opinion a top-heavy car is more easily lost control of than cars of the opposite kind. There is, I believe, greater weight of iron in the roof of the Bellamy extended type than in those of the old style. They carry more outside passengers, *and this additional weight is overhanging and extending considerably beyond the wheels.* Descending a steep grade I think the effect of this would be, especially when fully loaded outside, to depress the front part of the car unduly, almost lifting the hind wheels from the rails, thus depriving these wheels of much of the necessary frictional power. The track brake, too, would, but in a less degree, lose some of its frictional power. Consequently much of the means of retarding the car is lost.

A discussion on this subject should be interesting and instructive.

Progressive Manager.

December 15th, 1902.

Charging Cables.

It is a striking fact that, in many large power schemes now put down, the cables are not provided with charging apparatus, such as charging transformers, with a water resistance across one winding, and the cable in series with the other.

This method was used at Deptford and Willesden. Clothier says they are necessary in his Paper, "Construction of High Tension Switch Gear." (Inst.E.E., February 18th, 1902.)

Is it found to be an unnecessary precaution in many cases, or is some other and simpler method adopted ?

Henry N. Northcote.

Rugby, *December 15th*, 1902.

The Indication of Earths in Trolley Standards.

Under the above heading in your issue of the 28th ult., you have the following paragraphs :—

"It is, therefore, with apprehension that we observe certain devices being put on the market, which, in operation, first of all put a dead short on the line and then cripple the particular car on which the fault has occurred."

"At present we know two of these devices. One consists of a fuse which holds a switch-blade in an 'off' position till the fuse is melted by the passage of current between the trolley standard and earth. When this happens, the switch is pulled by a spring into contacts, which are joined respectively to the trolley standard and earth. At the same time, a bell starts ringing."

The device here referred to will be recognised as the "E.P.D. Earth Indicator," of which we are the patentees and sole makers. As your expressed "apprehension" is likely to do us considerable injury by creating an erroneous impression, we rely on your well-known fairness, in asking for a little space to correct the error.

It is true that our apparatus effectually earths the trolley standard and thus gives complete protection to the passengers, at the same time indicating the fault. But it is only in rare cases that it cripples the car, and this rare occurrence only applies to one form of the device, and only when there is a dead short between standard and cable. In both forms the indicator acts long before the insulation has so far broken down as to prevent the running of the car, which may be taken to the depôt, or even finish the day's work, with perfect safety to the passengers, notwithstanding the fault. This occurs in actual practice with cars fitted with our earth indicators.

If, however, an engineer or manager has an insuperable objection to a car being "crippled" even when there is a "dead earth," he can adopt the form of the apparatus in which the earthing switch can be re-opened by the driver or conductor. In this case, when a "short" is indicated, the trolley must be separated from the wire, and the passengers cleared from the top of the car, before re-opening the switch. The trolley may then be placed again in position, and the car run to the depôt.

Lamp indicators have two defects. They do not indicate until there is all but a "dead earth," and they offer no protection to the passengers. Further, they do not fulfil the requirements of the Board of Trade, referred to at the outset of your article.

With regard to the second (magnetic) device mentioned in your article, it should be noted that this form comes within one of our patents.

Edmondson & Purdom, Ltd.,
Walter A. Purdom,
Managing Director and Secretary.

Bradford, *December 12th*, 1902.

Reflections of an Electrical Engineer.

I style myself an electrical engineer, and as such I now analyse my feelings. I am not yet 25—I feel 50. I look back to the time when I was a bachelor, and to the time when the war rage was at its height—how I enlisted, the way in which I scrubbed out barrack rooms and stables, the perfect shine I obtained on the coat of my horse, and the way I sweated ! Then I was boxed up for three weeks on a transport with men and horses packed like sardines. I revel in the thought of how I lived on two biscuits a day, and how good they were ; how day after day I have tramped over the veldt with the smell of dead horses and oxen in my nostrils, how my pet horse became old and feeble with work, and how I became possessed of another. I look back to the time when I fought in well-known battles—battles in which the veldt fire played havoc with wounded men. I remember the times when, on a long march, I have wished myself back in the dirty, smoky town, learning to manufacture dynamos and motors. Such thoughts were sometimes dispelled by the shriek of a shell growing louder and louder, till it would pass and burst harmlessly in the distance, and then the thoughts of smoky towns would disappear, and dynamos and motors would be forgotten, and I would lie down and spend half an hour blazing away at a foe who had been doing their best to relieve this world of an electrical engineer.

All such things I remember well, and still better the day when as I lay on a kopje, a bullet struck me and I was returned home with others as no longer of any use, and was pensioned for life by a grateful country.

I look back to all this, but I look even beyond to the time when I travelled on the Continent, to the States and Canada, and yet further to the day when, raw from a public school, I was sent to work in a factory in the North of England to learn my present trade. How I loved the flap of the belts and the hum of the machinery, and for four short years I worked hard and enjoyed myself, fitting, turning, tool making, and the like. I remember how I bicycled and thought nothing of 60 to 100 miles on a Saturday afternoon. I soon became acquainted with most of the roads in the North Country, living from Saturday to Sunday at small inns, talking to farmers and labourers and enjoying their rural conversation and company.

I say that I now look back to all these things which certainly are no more, for when I returned from the war I did what many another has done, I married. My thoughts now return to this day as I join in conversation about curtains, carpets and papers, and as I view with complacent interest cushions and chairs covered with materials which would, no doubt, do credit in their colours to some rajah of the East.

Every morning I go down to an office where I meet likely customers. *How* they do talk, and after having succeeded in not allowing one to get in a word for fully fifteen minutes they go away, and one fails to discover what they came for. As a rule such persons have bought motors and cannot, or will not, pay for them. My work occasionally takes me to shipyards, and, as an engineer, I have lighted several boats.

I am now, alas, a teetotaller, which I was not in my bachelor days.

On my return home at night, I try to slip downstairs to the smoking room unobserved, so as to enjoy an hour or so experimenting with chemicals, electric motors, and such things. I am, however, soon recalled to the drawing room, where I have to listen with patience to Mr. Strachey's views on modern politics, as set forth in the columns of the *Spectator*.

Such is my present existence, as compared to my former mode of life, and as to which is the ideal, I must beg to be excused from expressing an opinion.

E. E.

BUSINESS NOTES.

Electrical Wares Exported.

Week ending Dec. 17th, 1901.		Week ending Dec. 16th, 1902.	
Amsterdam	Value £30	Alexandria	Value £288
Bangkok	21	Amsterdam	586
Bombay	437	Auckland	19
Buenos Ayres. Teleg. mat.	108	Bangkok	92
" Teleph. cable	75	Bombay	172
Calcutta	195	" Teleg. wire	150
Cape Town	540	Boulogne	16
Channel Islands	390	Calcutta	517
Christchurch	58	Cape Town	274
Christiania. Teleg. wire	50	Colombo	71
Colombo	141	Copenhagen. Teleg. cable	260
Copenhagen	220	Durban	980
Durban	540	East London	1,584
Fremantle	13	Karachi	315
Gibraltar	12	Madras	684
Hobart	192	Melbourne	467
Hong Kong	762	Napier	70
Madras	2,750	Ostend	377
Melbourne. Elec. cables	70	Otago	20
Nagasaki. Teleg. mat.	3,000	Perth	1,416
Otago	15,000	" Teleg. mat.	52
Penang	20	Port Elizabeth	80
Port Elizabeth	24	Rangoon	26
Port Said	100	Rockhampton	36
Progreso	35	Sydney	35
Reval	300	" Teleg. wire	287
St. Petersburg. Teleg. mat.	100	Teneriffe	552
Shanghai	168	Tokio	50
Sydney	197	Vera Cruz	4,528
Syra	35	Wellington	77
Toronto	133	Yokohama	30
Wellington	50		
Yokohama	176		
Total	£26,115	Total	£14,332

Foreign Goods Transhipped.

Christchurch.	Elec. mat.	Value £20	Perth.	Elec. mat.	Value £456
			Sydney.	Elec goods	150
			Total		£606

Crompton & Co., Ltd., v. H. W. Hulkes.—At Chelmsford County Court on December 10th, before Judge Tindal Atkinson, Messrs. Crompton & Co., Ltd., electrical engineers, of the Arc Works, Chelmsford, sued H. W. Hulkes for £5 19s. 2d., a month's salary in lieu of notice. Defendant was engaged as typist and shorthand writer at a salary of £1 7s. 6d. per week, and signed an agreement to give a month's notice. He, however, left four days after his engagement in order to take a better situation. In consequence the firm's correspondence was greatly delayed. Judgment was given for the plaintiffs for the sum claimed.

Tramcar Contract.—Messrs. Witting Bros., Electrical Engineers and Contractors, Ltd., have recently placed an order for 50 double-deck car bodies, capable of seating 55 passengers, with Messrs. G. F. Milnes & Co., of Hadley, and also for 50 trucks with fixed wheel base, with the Brush Electrical Engineering Co., these trucks being of their standard type and furnished with steel-tired wheels.

Institution of Junior Engineers.—At the meeting on December 5th, the paper read was on "The Planimeter, Explained Simply, without Mathematics," by Mr. W. J. Tennant. On the following Wednesday, December 10th, a visit was paid to the works of Messrs. Elliott Bros., at Lewisham. The members were shown over the works by Mr. W. O. Smith and Mr. G. K. Elphinstone.

Electrical Exports to South Africa.—The value of electrical goods exported to South Africa from the United Kingdom from October 1st to November 18th, says the *British and South African Export Gazette*, was £20,886, against £9,383 for the corresponding period of 1901. In addition telegraphic and telephonic material valued at £22,103 was also shipped, against £3,496 last year. The value of foreign goods transhipped was £4,030, compared with £70 in the preceding period. Last month electrical cranes to the value of £10,400 were shipped to South Africa.

Portuguese Electrical Tariff.—The *Board of Trade Journal* says that a Royal Decree, dated the 20th ult., raised a new heading in the Customs tariff for "vehicles (American system) for electric traction, incomplete (without the body)," and subjecting such vehicles to import duty at the rate of 100,000 reis each.

Roof Coverings for Double-Decker Cars.—The Huddersfield Corporation have had under consideration for a considerable time past the question of the advisability of covering in the tops of their cars, and after going fully into the matter, they decided to have a sample covering fixed. The Committee examined numerous types and placed an order with Messrs. G. C. Milnes, Voss & Co., of Cleveland Street, Birkenhead, for one of their Magrini patent collapsible coverings, for which they hold the sole right of manufacturing, and this has now been brought into service. The advantage of the covering is that the sides are easily lowered down by the conductor and driver together. It was originally intended to fix a canvas top and ends, but it was considered better in

Covered Car at Huddersfield.

such an exposed town as Huddersfield to have boarded ends and roof. Each side has three windows to harmonise with the body of the car, and the ends are also to have a hinged window, and a swing door is fixed at the top of each stairway. The inside height is not as great as many will desire, but is governed by several low bridges in the town. The sides will be easily hoisted up by means of a rod running the full length of the car with a ratchet and rack worked by a removable handle, so that only the conductor can operate same. The weight does not exceed 10 cwt., and it can be fixed to existing cars without any attention to or removal of top seats, trolley standard, &c. The covering having met with the approval of the public, the Committee have now placed an order for 10 more cars to be fitted.

B.T.H. Works.—The Coventry Engineering Society on Monday visited the works of the British Thomson-Houston Co., Ltd., at Rugby. The visitors were received by Mr. C. W. Phipps (works manager), Mr. Innes (assistant works manager), and other officials.

German Electrical Contractors' Association.—An Association of German Electrical Installing Firms has lately been formed at Frankfort-on-Main, with a view to fully represent the interests of German installers of heavy current plant. Nearly all the firms concerned have adhered to the association, which is greatly assisted by the Imperial and local Governments. A special commission has been entrusted with making suggestions as to a forthcoming reform of the German trade-marks system.

Catalogues and Price Lists.—Electromotors, Ltd., of Openshaw, have sent us a copy of their December price list of electric motors for continuous currents. Specification details are given, and prices, capacities, voltages, &c., are well arranged in tabulated form. The illustrations are small and neat, and the general style and arrangement are very satisfactory.

The Labmeyer Electrical Co., of New Oxford Street, W.C., have published an illustrated pamphlet, giving a full description, accompanied with a number of diagrams, of a method of measuring current, voltage, and energy in high-pressure installations. The arrangement is devised so that all measuring instruments, such as voltmeters, ammeter, wattmeter, and electricity meter, as well as phase lamps, are connected up to a low-pressure circuit, and are not

connected in any way with the high-pressure of the machines; they can therefore be touched without danger. The Wiesloch electricity works was the first station so fitted up by Messrs. Lahmeyer; it generates a 10,000-volt single-phase alternating current. The Lahmeyer Co. will send a copy of this pamphlet to any electrical engineer interested in the matter on application.

A well-bound collection of artistic designs of electric light fittings has been sent to us by the Electrical Fittings Co., of 38, Conduit Street, New Bond Street, W. Specimens of all these designs, and many others, can be seen in the showrooms, and a larger book is stated to be in preparation. French fittings have a room devoted to them exclusively at Conduit Street. The present catalogue is excellently arranged, a liberal allowance of space being given to each fitting, so that a correct idea of the general effect of the design may be obtained independently of others. High-class printing and a thick enamelled paper set the illustrations off to advantage. Standards, fancy brackets, electroliers, and so forth, are catalogued in polished brass and oxidised copper and silver; also in polished steel and copper enriched with translucent enamel. Electrical contractors and others interested in the sale of electric fittings of a high class for public and private buildings, will no doubt be anxious to secure a copy of this volume.

If there are among our readers any who take an interest in farming and stock-keeping, either as a hobby or as a business speculation—and we have no doubt that there are—they will find a fund of useful facts and figures in the *Agricultural Annual and Mark Lane Express Almanack* for 1903. It is published at 1, Essex Street, Strand (6d.).

The N.S. Electric Storage Co., Ltd., of 30, Stockwell Street, Greenwich, S.E., has sent out a price sheet of its batteries for lighting and tramway station use, also electrolytic service.

A tabulated price list of insulated electric wires and cables has been issued by Mr. B. G. Hodges, of St. Luke's Street Works, Derby.

The Liverpool Electric Cable Co., of Vauxhall Road, Liverpool, has sent us one of its calendars for 1903.

Returned from the War.—Last Saturday evening the reservists and volunteers in the employ of Callender's Cable and Construction Co., who have now all returned from the war, were entertained to dinner by the directors, and afterwards there was a gathering of the whole working staff of the company at the Christ Church Schools, Erith. The returned men were accorded a warm reception, and Mr. T. O. Callender was the subject of a most enthusiastic ovation. An excellent musical entertainment was provided, and presentations were made of a tantalus to Mr. Wood Jiggens, the secretary of the war fund, and a set of carvers to Mr. Kennard, who acted as treasurer. The number of men who left the Erith Works for the country's service was 47, 39 being reservists (27 married and 12 single), and eight volunteers (single men). Fourteen men from their outside works also did service. In regard to the fund the large sum of £2,046 was collected for the purpose of maintaining the wives and dependents. Of this amount the company themselves provided £1,446, and the men at the Erith Works alone £590. In addition there were considerable sums provided by men engaged in different towns on outside contracts. The company very generously subscribed half-pay for all married reservists called out. Voluntary contributions were collected weekly from the employés and were used to supplement this amount, and where there were children in the family an allowance of 1s. for each child was made. These voluntary contributions were also used for insuring the lives of the married reservists who went to the front. Weekly gratuities were also given to three other families where the single man had been the chief support of the family and widowed mother before being called out. In all, 83 persons had been maintained.

Books Received. — "Tramway Book-Keeping and Accounts," by D. McColl. London: Gee & Co. 1902. 10s. 6d.

"Physico-Chemical Tables; Vol. I. Chemical Engineering and Physical Chemistry," by John Castell Evans. London: Chas. Griffin & Co., Ltd. 1902. 24s. net.

"Annuaire pour l'an 1903." Paris: Gauthier-Villars. 1902. 1 fr. 50 c.

"Fire Tests with Automatic Fire Alarms." No. 66. London: The British Fire Prevention Committee. 2s. 6d. net.

Trade Announcements.—Messrs. Thomas Kesnor and Co. have sent us a pamphlet relating to their business. They have established works at Armadale Road, Fulham, S.W., where, as electrical, mechanical and experimental engineers, they receive ideas "in the rough," so to speak, and then construct working models, so that it may be demonstrated up to a point whether the ideas are, or are not, worth following up. Mr. H. J. Norballe, A.I.E.E., the firm's manager, has had considerable experience of this kind in Continental and American workshops. The Fulham works are equipped with a dynamo, battery, and various machines and instruments for testing purposes, and the manufacture of switches and switchboards, arc lamps, &c., is also carried on there.

The offices of the Typewriting Telegraph Corporation have been removed to 92, Queen Victoria Street, E.C.

Messrs. Doherty & Donat have removed to more commodious offices at Economic Buildings, Spring Gardens, Manchester.

Fire.—The electrical department of Messrs. J. Defries and Sons, in Houndsditch, was severely damaged by fire last Saturday morning.

Bankruptcy Proceedings.—A meeting of the creditors of Thomas Edward Morgan, electrical engineer, 367, Ecclesall Road, Sheffield, was held at the offices of the Official Receiver of that city on 9th inst. Mr. A. Muir Wilson represented the debtor. The Official Receiver stated that the debtor owed to unsecured creditors £127 12s. 5d., and to creditors partly secured £84 6s., less estimated value of security £20. There were no assets except a book debt, which was bad. The debtor commenced business in October, 1899, with Mr. David Mundey, trading as Morgan, Mundey & Co., electrical engineers, Eldon Street. In March, 1901, the business was transferred to College Street, Rotherham, but in the following month Mundey withdrew from the firm. Debtor continued until July, when he turned it into a limited liability company. He received 800 £1 shares as purchase money, and continued to be employed as manager until it went into liquidation in May last. The 800 shares were deposited as security, and in consequence of the liquidation they were only estimated to be worth £20. The other liabilities were in respect to debts primarily due by the company, but for which Morgan made himself personally responsible. The furniture was claimed by the father-in-law. The matter was left in the hands of the Official Receiver.

Liquidation.—Creditors of the Isle of Man Tramways and Electric Power Co. must send particulars of their debts, &c., to Mr. W. H. Walker, 50, Athol Street, Douglas, liquidator, by December 31st.

For Sale.—The Dublin Corporation has for sale five A.C. steam dynamos of 50, 150 and 200 KW., three sets "Brush" arc lighting steam dynamos, and water-tube and Lancashire boilers, being the equipment of the old electricity station. See our advertisement pages for particulars.

Trafford Park Recreations.—The second annual meeting between football teams from Glover's and Royce's took place on Saturday last at Trafford Park, where the cable-makers won easily by 3 goals to love. After tea a ping-pong match took place between selected members of the teams, when the dynamo builders took their revenge by 3 sets to 2.

Imports of Foreign Electrical Plant.—Rather a larger quantity than usual of foreign electrical plant and apparatus was imported into this country during last month, the returns showing a total of £58,212, as compared with £51,139 in October last and £58,029 in November, 1901. So far as the year has gone, however, there has been a big falling off in these imports. The total for the 11 months, ending with November last, amounted to only £623,606, as compared with £794,810 in the corresponding period of last year, and £1,118,760 in the first 11 months of 1900.

ELECTRIC LIGHT AND POWER NOTES.

Arbroath.—The T.C. has had under consideration a letter from the B. of T. on the subject of the Electric Lighting Order. Communications were also laid before the Council from companies offering to undertake the construction of the works. The town having been obliged to take up the question of a water supply for the burgh, the Council deems it inadvisable to carry out the Electric Lighting Order in the meantime, but desires that the Board will allow it to remain in force until the water supply has been dealt with.

Barnstaple.—Trials with the E.L. plant have proved satisfactory, but the T.C., after consultation with the engineer, Mr. W. H. Trentham, has decided not to commence the supply until after Christmas.

The T.C. has decided to purchase the Town Mills and the water rights pertaining thereto for £900, for the purpose of securing a water supply to the electricity works.

Bolton.—At the Corporation electricity station on 4th inst., the new generating plant was set in operation. Both Mr. A. Ellis, formerly borough electrical engineer, and Mr. A. A. Day, the present occupier of that post, took part in the proceedings. The new plant consists of two 1,500-H.P. engines by Messrs. Musgrave and Sons, direct-coupled to dynamos by the English Electric Manufacturing Co., of Preston, and it was the first of these that was started. They are of the vertical cross-compound condensing type, and run at a speed of 100 revolutions per minute. The number of units sold last year was 3,120,709. The gross profits amounted to £17,319, and after paying interest and depreciation, left a surplus of £4,751, £3,850 of which was paid in aid of rates.

Brazil.—The *Handels Museum* of Vienna states that the Brazilian Government having recently ordered that all steamers navigating on the Amazon must, in future, in order to obviate collisions, be provided with electric light projectors, a fairly large call for these apparatus may be expected. The regulation will apply to about 500 steamers, and the apparatus in question must be of from 2 to 5 KW.

Brighton.—The Portslade, Southwick and Shoreham U.D.Cs. are considering the advisability of jointly opposing the Brighton Corporation Bill, in which powers are being sought to supply in their districts, the object being to try to enforce a clause specifying that the price charged shall not exceed that charged in Brighton.

Buenos Ayres.—The following extract shows what some supply companies have to put up with:—"One of the electric light companies in Buenos Ayres, wild horses shall not make us reveal its name, which considers itself to be the most up-to-date in Buenos Ayres, has just been had, as if it were a child of tender years. The facts of the case are as follows:—A new shop was opened in the city, and a very large installation was put in. The proprietor, having no faith in meters, arranged with the company that he should pay a fixed sum a month for his light, it being agreed that the light should be turned out every night at eleven. The management, with a good client in its mind's eye, the installation being about 250 lights, made its calculations on the ordinary lighting hours. No mention was made in the contract about the hour at which lights were to be switched on, so the owner turns on about 8 a.m., and keeps them going full blast until 11 p.m. The company is now seeking for a loophole of escape, but we frankly confess that we hope it won't find it. The company in question has made itself most objectionable to all who have had dealings with it, on account of the overbearing manner of its employés, from the chief downwards, and those in the know are chuckling over its discomfiture."—*Review of the River Plate.*

Canada.—In his annual report on the use of electricity for lighting purposes in Canada, Mr. George Johnson, the Dominion statistician, says the number of electric lamps (counting an arc lamp as equivalent to 10 incandescents) is now 1,123,896, as compared with 943,676 in 1901 and 565,505 in 1898. In other respects the "electrification" of Canadian cities and towns is proceeding even more rapidly.

Carmarthenshire.—The county scheme promoted by the Carmarthenshire Electric Power Co. is entirely removed from the local undertaking. Llanelly has certain rights with regard to electric lighting and power under the provisional light railway order, but the promoters of the Bill for the county do not seek to interfere with the existing rights of the town. A conference of electric and local authorities is suggested.

Colwyn Bay.—The Council has decided to apply for sanction to borrow a sum of £2,680 for the extension of the electricity works.

Coventry.—The National Electric Wiring Co. has written terminating its agreement with the Corporation for free wiring at the expiration of six months.

Cowpen.—The Northern Counties Electricity Supply Co. recently informed the U.D.C. that, owing to the water-logged condition of some of the streets in Waterloo, they had been compelled to disconnect several consumers. As their statutory obligations could not be fulfilled if the streets were permitted to remain in their present state, they asked the Council what it intended to do in the matter. The Council has decided to take no action.

Croydon.—On Thursday Mr. W. A. Ducat, L.G.B. inspector, held an inquiry into an application of the Corporation for sanction to a loan of £45,000 for purposes of electric lighting. Mr. Scott, borough electrical engineer, explained the use that was to be made of the money, as follows:—Two water-tube boilers, £3,500; mechanical stokers, £850; buildings, foundations, &c., £650; engine and dynamo, 600-KW. set, £7,000; pipework, foundations, switchboard, cables, &c., £1,000; condensing plant, cooling and storage pond, air-pumps and pipework, £1,200; surface condenser and circulating pumps, £5,181; buildings, &c., £1,200; water-purifying plant, £440; direct current mains and extensions, £3,810; additional consumers (say at £10 per consumer), £8,000; sundry extensions, transformers, &c., £8,000. To the estimate for plant and mains is added 10 per cent. for contingencies. The electrical engineer said that this new expenditure was rendered absolutely necessary by the great increase in the demand for electric light in the borough. The application was unopposed.

Mr. J. Gray Scott, borough electrical engineer, read a paper at the Croydon Central Library on Thursday last week on "Electricity."

Davos.—A Continental correspondent says:—"The town of Davos, Switzerland, will be the first in Europe to employ electricity, not alone for lighting, but for heating hotels and houses and for all industrial and domestic uses. Before the end of the year, all combustibles will, in all large establishments, have given place to electricity, which will, in the near future, be the sole artificial medium of light, heat and energy. Two important mountain water-falls have been used by the engineers, and generating plant of a total power of 5,000 to 6,000 H.P. has been installed. Already a large number of hotels and private villas have adopted electric heating, by means of radiators, and electric cooking utensils are in use in many kitchens. The principal bakery in the town bakes its bread by means of an electric oven, and the laundresses do their work with the aid of an electric iron."

Devonport.—The T.C. intends to apply for power to borrow £30,000 for the purposes of the electric light undertaking. The total amount of money borrowed on the works is £79,000, and that sum has already been exceeded to the extent of over £6,000.

Dorchester.—The T.C., whose prov. order expires on July 6th next, has obtained information from a number of towns respecting electric light undertakings, municipal and otherwise, and has requested the consulting engineers, Messrs. Enright & Co., to advise the E.L. Committee further on the subject.

Egremont.—A L.G.B. inquiry has been held into the application of the D.C. for leave to borrow £52,353 for electric lighting and traction.

Frodingham.—The ratepayers, by a unanimous vote, have approved of the action of the U.D.C. in deciding to apply for a prov. order under the Electric Lighting Acts.

Galashiels.—The T.C. has resolved to remit to a committee to consider and report upon the introduction of electric lighting into the burgh under the prov. order, and to ascertain whether it would be best for the Corporation to carry out the work, or to have a private company to carry it through.

Gillingham.—The D.C. (Chatham) has passed resolutions for the borrowing of £26,659 for the purchase of part of the undertaking of the Chatham Electric Lighting Co., situated at New Brompton. The Council will now take over these works, and carry them on for the benefit of the public.

Hove.—On the application of the Hove Electric Lighting Co., the B. of T. will hold an inquiry on December 20th respecting the company's request for permission to compulsorily raise the pressure of supply from 110 volts to 220 volts in the centre of the town. The outlying districts have been supplied at 220 volts for some time, but many of the low pressure consumers have raised objections to having their supply pressure raised, hence the inquiry. The buildings for the company's new generating station in Aldrington are now approaching completion, and some of the new plant should soon be delivered.

Kent.—The Kent Electrical Power Syndicate has been asked by Faversham T.C., which recently obtained a prov. order, for terms for the supply of electricity to the town. In consequence of this the company has approached the Milton U.D.C. with the object of supplying Faversham, Milton and Sittingbourne. It is pointed out that if the three towns amalgamated on the question, energy could be supplied at a cheap rate, owing to the size of the district.

Kilmarnock.—The T.C. has agreed to appoint Prof. Kennedy as engineer for the proposed electric lighting and traction scheme. The traction is to be confined to a line with loops from Beansburn to the burgh boundary at Riccarton. A provisional order for lighting has already been obtained, and an order for traction will be applied for in April.

Kimberley (S.A.).—The T.C. not being satisfied with the terms of the De Beers Co. for supplying energy for extending the lighting of the town, has decided to carry out an extension of its own plant, for which an expenditure of £10,000 has been sanctioned.—*B. and S.A. Export Gazette.*

Leek.—The B. of T. has informed the U.D.C. that, under the circumstances, the Board will defer consideration of the question of revoking the Council's prov. order for a year.

Leigh.—In respect to the proposed electric lighting scheme, the U.D.C. has resolved that a committee meet a Committee of the Southend Corporation to discuss a joint scheme.

Lodore Falls.—The new owner of Lodore Hotel and Falls has completed arrangements to utilise the famous falls to supply electricity for lighting the hotel and for other purposes. The work has been planned in such a way as to entirely avoid any interference with the picturesqueness of Lodore and its surroundings.

London.—CAMBERWELL.—The Finance Committee of the M.B.C. has reported having had under consideration an application of the London Electric Supply Corporation to the B. of T. for an extension of its area of supply to the entire borough. The borough is at present supplied over nearly its entire area by the County of London and Brush Provincial Electric Lighting Co., Ltd., and in a small portion by the Crystal Palace and District Electric Lighting Co., Ltd. The London Electric Supply Corporation has powers to supply, and is supplying that portion of the borough north of the London, Brighton and South Coast Railway line. Last year the Borough Council applied to the B. of T. for a prov. order sanctioning the purchase of the London Electric Supply Corporation's order, but owing to conditions imposed by the Board to the effect that the Brush Co.'s undertaking would also have to be purchased, it was not deemed advisable to proceed with the order. The Committee considered the London Electric Supply Corporation's application was one that should be supported in the interests of the borough and recommended accordingly.

Mr. Lane Mitchell, chairman of the Committee, explained that the Supply Corporation was practically acting on behalf of the Borough Council. If the Council did not support the application, it would be withdrawn.

The Town Clerk replying to questions said, supporting the application would not bind the Council to buy out the Corporation. There was no obligation expressed or understood to purchase the undertaking beyond the fact that last year the Council entered into negotiations which were not proceeded with, owing to the action of the B. of T. It would be useless for the Council to apply for an order for itself, as two orders had already been granted.

A proposal to refer the matter back having been negatived, the Committee's recommendation to support the application of the London Electric Supply Corporation was agreed to.

BATTERSEA.—The Borough Council has decided to extend the distributing mains and arc light mains at an estimated cost of £900. It was further resolved to apply to the L.C.C. for a loan of

£523 for wiring and fitting up with electric light the Borough Council's stores and workshops.

STEPNEY.—The M.B.C. has discussed and adjourned a recommendation of the E.L. Committee that Upper East Smithfield be lighted with arc lamps at an estimated cost of £750.

WOOLWICH.—The T.C. has decided to inform the County Council that it is strongly in favour of the renewal of the application to Parliament for powers to enable Metropolitan Councils to wire and fit consumers' premises for electric light, and obtain loans for that purpose.

Ludlow.—The T.C. on December 10th discussed a proposal to transfer its prov. order to Mr. John Parker, of Hereford, for £225, the Council to pay Mr. Parker £75 for services rendered as engineer of the E.L. scheme, and have the option of purchase at the end of 10 years. The question was adjourned until January.

Midland Junction (W. Australia).—The T.C. recently inaugurated an installation for the supply of electricity for public and private lighting. The plant consists of a Sturtevant steam dynamo of 50 KW. output, which was to have been supplied with steam by two Paxman "Economic" boilers, but these, unfortunately, were lost in the wreck of the *Deptford*. Two more are being sent out to replace them, and in the meantime a portable boiler is in use. There is a Crompton balancer in the station, the three-wire system at 220—220 volts being employed, and the public lighting is effected by means of nine Crompton arc lamps and 42 glow lamps. The contractors for the work were Messrs. Splatt, Wall & Co., of Perth, W.A.

Nairn.—Messrs. Crompton & Co. have offered to take over the burgh's E.L. prov. order on certain terms, the principal of which were payment of £150 to cover the expenses of procuring the order, and an annual payment of £30 for the first five years, and £50 annually thereafter.

Newport (Mon.).—Mr. H. F. Parshall, consulting electrical engineer to the Corporation, has reported specially upon a certificate issued by him, in favour of the Callendar Cable and Construction Co. The report states that the firm having completed their contract for cableways, the total expenditure incurred was £4,236 17s. 4d. The amount of the contract was £3,514 19s. 6d., being a net figure based upon 2 ft. of cover from the surface of the roadway to the top of the concrete surrounding ducts, and not containing any fixed sum for contingencies; this being impracticable in work of this class. Of the amount of the difference of £721 17s. 10d., the sum of £561 1s. 9d. was incurred in laying the cableways along the approaches to Newport Bridge, where it was found that, owing to the layers of water and gas pipes underneath the roadway of this portion of the route, it was necessary to lay the cableways from 12 ft. to 18 ft. below the surface of the roadway. There were two ways of doing this, either to dig a trench to the depth mentioned; or to drive a heading, lay the pipes, and fill up the heading again with concrete. After consulting with the borough engineer, the latter method was adopted in order to avoid interference with the traffic over the bridge. The estimated cost of open-trenching was £400, so that an expenditure of £160 had been incurred, in order that no restriction might be placed upon the traffic at its most congested point in Newport. The extras on the remainder of the route were £247, being under 7 per cent of the contract sum, the usual allowance for contingencies being 10 per cent. Upon this explanation by Mr. Parshall, the committee has resolved to pay the account. The Corporation has undertaken to supply energy for motors to Messrs. J. J. Cordes & Co., proprietors of the Dos Nail factory, for use day and night, at 1d. per unit net, with a proviso that the minimum consumption is to be 100,000 units per annum.

Niagara.—The *Montreal Star* gives the following particulars of a test unique in the world's history:—Ever since power house No. 2 of the Niagara Falls Power Co. was commenced, the question as to the effect of passing 100,000 H.P. through the main tunnel has been the subject of discussion and computation. Now that units 11, 12 and 13 of 5,000 H.P. each have been completed in power house No. 2, and units 14, 15 and 16 have been so far completed that water could be passed through the wheel cases without the wheels, it was decided to make a practical test of passing the full quantity of water to be used in power house No. 2 through the tunnel, in addition to the full operation of power house No. 1, and of the paper mill. This was done Nov. 19th, commencing about 10 o'clock, and closing at 5.15 p.m., during which time a variety of hydraulic experiments were conducted to the end above referred to. At one time the paper mill, using 8,000 H.P., was, by the kindness of the company, shut down completely, so that the effect of this additional power could be observed. The results of the tests are said to have been entirely satisfactory, the tunnel discharging all the water used in a development of 100,000 H.P. The effect upon the lower river by the doubling of the discharge through the tunnel was noted. The increased current impinged with considerable force upon the Canadian side, dividing the foam carried by the surface current, so that part of it passed up stream and part down. It is believed that this will aid rather than deter the formation of ice bridges by keeping the floating ice well up stream.

North Wales.—Messrs. Rowcliffe & Co., Manchester, have written to the Flintshire County Council stating that a syndicate intends to apply for powers to erect electricity generating stations, and to lay mains for the supply of electricity and power-gas throughout a district comprising 2,000 square miles, including the Borough of Flint, the Urban Districts of Buckley, Cimmod's Quay, Mold and Holywell, and the Rural Districts of Holywell and Hawarden.

Norway.—We learn from *Elektrot. Tidsskrift*, Christiania, that the "Norsk Elektrisk Aktiebolag" has been entrusted with the installation of a large plant for the transmission of power from Evenstad Falls to Arendal and Grimstad, Norway. At the Evenstad Falls, which, when fully utilised, will yield about 8,000 H.P., two 1,250-H.P. turbines are installed for a beginning, each running at 125 revs. per minute, and there are two three-phase generators of 1,000 KW., each directly coupled to them, serving at the same time as fly-wheels to the turbines, each of which has a weight of about 40,000 kg., the rotating magnetic field alone weighing half, and the diameter being 5 m. From the generators the current is led to six 340-KW. single-phase transformers, converting the pressure to the value of 17,000 volts required for the transmission. The total length of the transmission line is somewhat more than 30 km., the distance of Arendal being about 10 km. and that from Arendal to Grimstad about 20 km. Between Arendal and Grimstad there is a populous industrial district, and it is intended to provide this with electric light and power. At the various distributing stations the high-pressure current is first converted to 2,000 volts, this pressure being used with all large motors. For lighting purposes, and for use with smaller motors, this is subsequently converted to 220 volts. The turbines are supplied by the Drammen Iron Foundry and Engineering Works.

Oldham.—The E.C. has reduced the price of energy to private consumers from 2d. to 1½d. per unit consumed after the first two hours. On the old system a 10-hour-a-day consumer paid 2·4d. per unit, but now it will be 2d. per unit. The reduction has been made to encourage long-hour consumers. There was also a sliding scale from 4d. per unit to 2d.; this has been revised, and consumers on this scale will be charged 1½d. per unit for all units consumed over 5,000. A reduction of ½d. (from 1½d. to 1½d.) has been made for traction.

Queenborough.—The Kent County Electrical Power Distribution Co. has offered to supply electricity on the following terms:—Private consumers' maximum price, 7d. per unit with a sliding scale to 2½d.; public lamps, 70s. each per annum for all-night lamps, and 50s. if extinguished at midnight; arc lamps £15 per annum up to midnight, and £25 if burning all night.

Salisbury (Rhodesia).—A scheme is on foot for lighting the town by electricity. According to the plans drawn up by Mr. C. Lindesay, the town engineer, the estimated cost will be about £50,000.—*B. and S.A. Export Gazette.*

South Wales Mines.—Some time ago the United National Colliery Co. placed an order with Messrs. Bruce Peebles and Co., of Edinburgh, for electrical hauling and pumping plant, the power for which will be taken from the South Wales Electrical Power Distribution Co. The first instalment of plant consisted of a 100 H.P. three-phase motor and pump, and a 150-H.P. three-phase hauling gear. Since placing the order for this plant the colliery company has become so firmly impressed with the economy, safety, and inconvenience of electricity that it has now placed an order for an additional 535 H.P. The new plant consists of two 150-H.P. three-phase hauling gears, each capable of taking 20 loaded trams a distance of 2,000 yds. at a speed of 10 miles per hour. Four three-phase motors and pumps—two of 50, one of 25, and one of 10-H.P. By June of next year the colliery will be equipped with 800-H.P. of three-phase electrical plant. The South Wales Electrical Power Distribution Co. is building a sub-station at Wattstown, wherein will be placed the transforming apparatus in which the 11,000-volt current will be brought down to the 500-volt current that will be taken down the pit. From the Pontypridd generating station the power company will also supply the New Windsor Colliery Co.'s pit at Aber with energy for underground pumping and for a variety of other purposes on the surface. Underground there will be a 100-H.P. three-phase motor and pump, and on the surface, for a start some half-dozen or so three-phase motors driving mortar mixers, saw benches and other machines.

Southampton.—The L.G.B. has sanctioned the borrowing by the Council of the sums of £3,082 and £4,315 for the purposes of the new electricity generating station on the Western Shore and for laying the new cable.

Stonehaven.—The T.C. has received an offer from Mr. J. G. Warden-Stevens, London, to come to Stonehaven and go into the matter of electric lighting for 15 guineas.

Stoke-on-Trent.—Mr. G. R. Peers, of Manchester, on December 11th, submitted to the R.D.C. a scheme for the electric lighting of Bucknall by means of 48 60-C.P. incandescent lamps of the latest type, and assuming that the steam from the sewage works boilers was utilised, the plant, &c., would cost £1,750, and cables £1,449. This would light the street lamps and 800 other lamps, He estimated the annual expenditure at £425, and the revenue at £501. It was decided to ask the L.G.B. to sanction the use of the sewage works for the E.L. station.

Sunderland.—At a special meeting of the Electricity Committee of the Sunderland Council on the 10th inst., a letter was read from the Durham County Electrical Distribution Co., offering to supply electricity in bulk, the company to make what use they could of the two Corporation stations, and deriving the rest of the power from their station on the Tyne, and it was suggested that the company could supply electricity at least 20 per cent. cheaper than the Corporation. It is understood the proposal was that the Corporation would continue to supply lighting customers and the tramways,

while the company would supply the power consumers, such as shipyards and engine works. Mr. Snell, the borough electrician, expressed the view that the Corporation would have all the cost of distribution to bear, and that the electricity would be delivered by the company on the three-phase high-pressure system, and would have to be transformed to low pressure, which would entail a loss. . . . . After long discussion the matter was adjourned, and Mr. Snell was asked to report at the next meeting.

Col. A. J. Hepper held an inquiry at Sunderland on the 11th inst. into the application by the Corporation for sanction to borrow £74,000 for electrical extensions in the borough. The town clerk said that since 1894, when the undertaking had been started, it had gradually increased. They had had sanctions to borrow £216,635, and of this they had spent £197,282 on works and mains; the income had increased from £2,000 to £26,378 in the seventh year; and while they had paid off £13,613 for sinking fund, and £13,507 as interest, there had been a net profit of £1,346, which had been placed to the credit of the reserve fund. No profits had been devoted to the reduction of the rates. The money applied for was for the extensions needed for the ordinary increase of demand, except about £6,000, which was for the purpose of generating energy for motor purposes. They were about to build sub-stations and transmit high-pressure current generated by three-phase alternators to sub-stations, whence it would be distributed at the ordinary low pressure. Mr. Snell, the borough electrical engineer, submitted a statement as to the growth of the undertaking. One table of this shows the growth from March 31st, 1896, to the present time, when there were 721 consumers, 67,748 8-c.p. lamps connected, the maximum load being 1,640 kw., the units sold being 2,375,557, and the load factor 16 per cent. Other formal evidence was given, and the inquiry concluded. The Corporation has accepted the report of the E.L. Committee that electricity on the slot-meter system be supplied for lighting the new workmen's dwellings.

Swindon.—The T.C. has fixed the following scale of charges for electrical energy:—For lighting, 5d. per unit, or 2d. per unit for all current consumed, plus a capital charge at the rate of £7 10s. per kw. of maximum demand per annum; for motive purposes, 2½d. per unit.

Swinton and Pendlebury.—Salford Corporation has informed the U.D.C. that the clause in its Bill giving it power to take over the Swinton and Pendlebury E.L. order will be deleted, as requested.

Negotiations are in progress with the Lancashire Electric Power Supply Co. for a supply of electricity to the district.

Thames Ditton.—The U.D.C. has appointed a committee to consider the advisability of applying for a prov. order for electric lighting.

Tipton.—A dispute has arisen between the U.D.C. and the Midland Electric Corporation for Power Distribution respecting the supply of electricity to private consumers. It appears that some time ago an agreement was entered into between the Council and the corporation, by which the latter undertook to supply the former with energy in bulk at a stipulated price, and the Council considered that they were free to supply customers, out of which transaction it was proposed to make a profit. The corporation, however, have put an entirely different construction on the agreement, which they contend has only reference to supplying the Council with energy for their own use, and as they hold a Bill empowering them to supply private consumers, they decline to allow the point to go to arbitration, although it is understood that they are prepared for the question of the price to be charged per unit to be decided by a B. of T. arbitrator in the event of any dispute.

Tunbridge Wells.—On Wednesday evening last week the annual official visit of the Corporation and representative bodies of the borough to the electricity works took place. Alderman Elvy Robb, chairman of the E.L. Committee, assisted by Mr. Horace Boot, the borough electrical engineer, received the guests at the works. There was much to see at the works illustrative of the progress made in electrical machinery, and many interesting experiments were made by Mr. Boot. In a souvenir presented to each guest during the evening, it was explained that the electric system in the Tunbridge Wells district covers 4,000 acres, with 66 miles of cable, supplying 55,000 8-c.p. lamps. Up to date the capital expenditure upon the undertaking has been £70,000, the total gross profits since the opening £19,262, and £2,750 has been contributed towards the reduction of the rates. Since the commencement the works have been enlarged four times.

Walsall.—The T.C. has decided to apply for a loan of £10,050 for the extension of mains at £6,350, and the provision of a sub-transformer station, with equipment and feeders, for the Highgate and Caldmore districts, at £3,700.

Walton-on-the-Naze.—The U.D.C. has entered into an agreement with the Coast Development Co. for supplying all the public lamps in the town with electricity for three years, at a charge of £2 15s. per annum per 16-c.p. lamp.

Ware.—Negotiations are proceeding with the electric supply company for the leasing of the U.D.C.'s prov. order for electric lighting, and terms have been practically agreed upon.

Watford.—The Government auditor has surcharged the U.D.C. to the extent of £110, in respect to electric lighting in six new streets beyond the area of the prov. order. The L.G.B. is to be asked to remit the surcharge.

Whitehaven.—The T.C. having received a request to wire and fit up St. Nicholas' Church, has decided to communicate with the B. of T. on the question of the Corporation taking up the wiring and fitting-up business, as the Council's order does not contain the necessary authority.

Wimbledon.—On December 10th the U.D.C. appealed to the Kingston-on-Thames Union Assessment Committee against the assessment of the E.L. works, which had been fixed at £4,921 gross and £3,223 net, and the figures were reduced to £3,900 gross and £1,700 net by the Assessment Committee.

ELECTRIC TRACTION NOTES.

Ayr.—Last week an adjourned meeting of the T.C. considered whether the terms on which the electric department supply for the tramway system should be revised. The present price charged to the tramways is 1½d. per unit for 200,000 units, and 1d. per unit beyond that. Mr. T. Young, convener of the E.L. Committee, moved that the price be 1½d. for the whole amount supplied, the arrangement to run from September. After discussion, however, it was resolved by 7 votes to 6 that it was inexpedient to interfere with the present terms till July, as the whole tramway system would not have been run a whole year till July.

Belgium.—The Nürnburg Continental Society for Electrical Undertakings has applied to the Belgian Ministry for a license to construct a high-speed suspension railway between Brussels and Antwerp. The speed is intended to be 150 km. per hour. The cost is estimated at 26 million francs.

Birkenhead.—The T.C. has decided to introduce a halfpenny fare in the working of its electric car system.

Bollington.—The U.D.C. has decided to support the electric tramway scheme promoted by the Macclesfield and District Traction Tramway Co.

Dundee.—"Electrical Development in America" was the subject of a paper read by Mr. A. Morris Thompson to the Dundee Society of Experimental Engineers last Saturday week. Dealing with the development of electric traction, he said tramway rails in America were almost universally laid on cross wooden sleepers, as in the case of railways, and the street surface was made good on the top. The comparatively low cost of this method of construction rendered it feasible to lay lines radiating from a town into the outlying districts to distances of from 20 to 40, and in some cases 60 miles. In his opinion such methods if adopted here would allow of cars going from Dundee to Arbroath and Perth, and in time possibly also to Newtyle and Forfar.

Dewsbury.—A trial trip was run last week-end on the Thornhill section of the B.E.T. Co.'s tramway system, and it was successful. It was hoped to have this section completed so that cars could be running for Christmas. There are several little matters to attend to yet, however, and our correspondent learns that it is not likely that cars will be run for the public use before the new year. Progress is being made in other directions, and it is hoped that ere long the section from Dewsbury to Ravensthorpe will be ready for service.

Exeter.—The City Council last week formally decided to give Messrs. Burt, of Cornhill, notice of the Corporation's intention to purchase the present small system of horse trams, which is to be converted and absorbed into the larger system of overhead trolley cars, which are to be provided and worked by the Corporation.

Handsworth.—The D.C. has decided almost unanimously to throw in its lot with the British Electric Traction Co., and to support their Bill.

Ince and Hindley.—The U.D.C.'s have decided in favour of leasing the tramways to Wigan Corporation. Ince to have the right to supply energy on terms to be agreed upon.

Keighley.—The T.C. has been recommended to electrify the present tramways in the town, and to apply to the B. of T. for a prov. order to construct an electric tramway from the top of Cavendish Street to the borough boundary at Stockbridge, at an estimated outlay of £32,459.

Littlehampton.—The U.D.C. held a special meeting on December 9th to consider the proposals of the B.E.T. Co. *re* the Hove, Worthing, and Littlehampton electric tramways scheme. Mr. Hederstedt, a representative of the B.E.T. Co., attended, and assured the Council that the company would carry out the scheme in its entirety. The West Sussex County Council, he pointed out, had supported them in the strongest possible manner, and they still had hopes of making terms with Hove and Worthing, while, with the exception of Portslade, all the intervening authorities between Hove and Worthing had given them hearty support. The company would ask for five years in which to carry out the work, but they would start upon the construction as soon as possible. It was decided to defer decision for the present, with the object of calling a special meeting to further consider the scheme.

Llangollen.—The R.D.C. has decided to support the application of the Shropshire, Worcestershire, and East Denbighshire Electric Power Co. for power to construct an electric railway from Chirk, through the Glyn Valley, over the Berwyn Mountain, to Llangollen, and thence to Chirk. There will be overhead equipment, and it is proposed to erect generating stations at Hadley, Stourport, and Trevor.

Manchester.—The working of the horse cars from the city boundary to the village of Stretford terminated abruptly on Friday evening as the result of a dispute between the Manchester Carriage Co. and the Stretford Urban District Council. The old tramway belongs to the Carriage Co., and as no purchase money had been paid they disputed their right to its use, and obtained an injunction both against the Council and the Manchester Corporation, which was temporarily working them prior to electrification. Meantime the inconvenience to the general public is very great.

The receipts on the Corporation tramway lines show an almost continuous increase. Last week they reached the high figure of £7,500, and the number of passengers carried was 1,639,166, as compared with £7,434 received, and 1,627,582 passengers carried in the previous week.

Norway.—The Christiania Electric Tramway Co. have, according to *Elektroteknick Tidsskrift*, equipped some of their cars with a station signalling device; the apparatus is placed in a box attached to one of the doors of the car. By pushing up and down a handle placed at the right of the box a bell signal is sounded, and the apparatus shows the name of the following station.

Rochester.—The T.C. has sealed a petition to the House of Commons for leave to bring in the Rochester Corporation Tramways and Improvements Bill. This is the sequel of a meeting of owners and ratepayers of the city, who have (with only one or two dissentients) authorised the Corporation to promote this Bill for constructing municipal tramways.

Southport.—The total number of passengers carried on the Southport electric trams has been 2,304,323, as compared with 2,218,099 in the period between April 1st and November 8th, 1902. The receipts on the High Park section dropped from £3,594 to £3,098, and on the inner circle from £3,115 to £2,945. On the Blowick section there was an increase to £1,785 from £1,755. On the Kew section, the figures were £2,016, against £1,948 last year. £547 was received from the Sefton Street section. The total receipts were £10,693, compared with £10,609. For the year ending December 4th (47½ weeks), the total receipts on the lines of the Southport Tramway Co. have been £12,310, or an increase of £4,476 contrasted with the same period last year. The large increase on these lines is due to the new service to Birkdale.

Major Druitt, inspector of the Board of Trade, on Friday went over the new tram route. This new service started on Saturday (13th). The horse cars along Sefton Street were discontinued the same day.

South Shields.—A special joint meeting of the Tramways and Parliamentary Committees was held on 12th inst. to consider the last letter that had been received from the B.E.T. concerning the tramways in the borough, for which the Corporation is promoting a Bill for powers to make extensions and convert the present system to electrical or other mechanical traction. The B.E.T. are promoting a Bill for powers to construct a light railway from Sunderland to South Shields, and there had been some suggestion that each of the parties should have over certain portions of the other's lines running powers. At the meeting on the 12th our correspondent understands that this was withdrawn on the part of the B.E.T., and they now reverted to an earlier suggestion, that was that the company were prepared to transfer to the Council so much of the Jarrow and South Shields light railway as is within the borough on terms to be agreed upon; to take a lease of all suitable tramways to be constructed in the town for a period of 28 years; the company to pay the interest and sinking fund upon the capital expended, and relieving the Council of a debt of £10,000 now standing against the tramways account. The company also offered, if the Council desired, to include in their Bill for the Sunderland and South Shields tramways the powers required for lines in the borough so as to avoid the expense of a separate Bill. After long deliberation the town clerk was instructed to write to the company stating that the Council was prepared to discuss the question of running powers to which reference had been made, but that they were not prepared to discuss the question of leasing the whole of the tramlines in the borough.

Stockport. — The borough tramways are reported to be showing a much better financial return than was the case a year ago. The receipts for the week ending on Saturday last on the Woodley, Reddish and Cheadle routes amounted to £219, as against £103 in the corresponding week of 1901. More than double the number of passengers were carried.

Swinton and Pendlebury.—Salford T.C. has asked permission to borrow £59,500 for the construction of electric tramways in Swinton and Pendlebury.

TELEGRAPH AND TELEPHONE NOTES.

American Pacific Cable.—As mentioned in the report of the India-rubber Co.'s meeting appearing in our "City Notes" to-day, the American Pacific cable has been successfully landed at San Francisco.

Brighton Telephones.—Mr. Bennett's report to the Telephones Committee was to come before the T.C. yesterday.

In consequence of the reduction in the specified quantities of apparatus and material necessitated by the exclusion of Hove and the postponement of the execution of work in the rural portions of the area, the Committee invited amended tenders from those firms whose original tenders had been recommended to favourable consideration, and they now recommended the acceptance of the following tenders:—

Material and Firm.			
Conduits, Henley's Telegraph Works Co., Ltd.	£5,514	19	4
Cables, British Insulated and Helsby Cables, Ltd.	2,452	0	0
Poles, Armstrong, Addison & Co.	1,081	10	6
Insulators, International Electric Co.	247	13	7
Arms, Millars, Karri and Jarrah Forrests (1902), Ltd.	80	11	0
Ironwork, Bullers, Ltd.	132	1	8
Bolts, T. W. Lench, Ltd.	22	0	0
Copper wire, T. Bolton & Sons	277	18	4
Bronze wire, W. F. Dennis & Co.	234	3	4
Iron and steel stay wire, ditto	38	15	0
Insulated wires, ditto	209	0	0
Lightning arresters, International Electric Co.	304	1	8
Primary batteries, Atlas Carbon and Battery Co.	70	0	0
Instruments, Ericsson Bell Telephone Co.	2,516	17	6
Switch tables, ditto	1,274	0	0
	£14,426	5	11

The engineer advised that it will be cheaper for the erection of the overhead work and the fixing of the subscribers' instruments to be carried out by workmen in the immediate employ of the Corporation, rather than that any of the tenders for this work should be accepted. The following are the particulars of the most favourable tenders for the performance of this work:—

Execution of overhead work, Reid Bros.	£4,354	10	9
Fixing of subscribers' instruments, ditto	302	0	0
	£4,656	10	9

Mr. Bennett advises that several hundred pounds will be saved upon this amount if the Corporation undertake the work themselves. The Committee therefore recommended the Council to reject all the tenders for the erection of the overhead work and the fixing of the subscribers' instruments, and to authorise the Committee to engage the necessary staff, and to arrange for the execution of the work under Mr. Bennett's supervision. The Committee also received the following tenders for the construction of the necessary switch-room on the site at the Pavilion granted by the Council:—

A. Crowhurst, Chichester	£907	0	0
W. A. Field & Co., Brighton	930	0	0
Payne, Norman & Co., Brighton	984	0	0
Box & Turner, Ardingley	1,057	0	0
Sattin & Evershed, Brighton	1,064	0	0
J. Longley & Co., Crawley	1,140	0	0

The Committee recommend that the tender of Messrs. Field & Son be accepted. The total amount of the tenders for the several works above set out is £15,333 5s. 11d., which, added to the estimated cost of erecting overhead work and fixing subscribers' instruments, makes the actual cost of the work in the smaller areas £19,989 16s. 8d., and the Committee recommended that the work be put in hand forthwith.

German Cables.—Germany is planning the laying of cables from the Azores to Dutch Guiana. The Washington correspondent of the *Daily Telegraph* states that this is part of Germany's programme for the construction of cable lines, in order to avoid being dependent on the English wires in time of war.

Paris Telephones.—A *Times* telegram says that, on account of the deficit and other difficulties, the reduction of the Paris telephone rate from 400 francs to 300 francs a year, which was promised for New Year's Day, will not take effect.

Venezuelan Telephones.—A telegram from Caracas dated the 12th inst. states that the Venezuelan Government has seized the English Telephone Company's office, and has appointed its own managers.

The Pacific Cable.—In the House of Commons on Wednesday, Mr. A. Chamberlain (for the Secretary of State for the Colonies), in answer to Sir E. Sassoon, said: The length of the recently laid Vancouver-Fanning section of the Pacific cable is 3,457·76 nautical miles. The central wire of the conductor is surrounded by spiral copper strips, and the average weight per nautical mile of the completed conductor is 607 lbs., having a resistance of 1·990 B.A. ohms per nautical mile at a temperature of 75° F. The inductive capacity of the core, as laid and tested by a null method, is 0·419 microfarad per nautical mile. Owing to the want of technical precision in the question relating to the resistance of the dielectric reduced to 75° F., there is some uncertainty as to the exact information required; but, assuming that the question refers to the dielectric resistance after one minute's electrification reduced to 75° F. and to atmospheric pressure, this value is 1,726 megohms per nautical mile as calculated from the tests made after the laying of the cable. The signals were received on the syphon recorder.

Telegraphic Interruptions and Repairs :—

Cables.	Interrupted.	Repaired.
Latakia-Cyprus	June 20, 1899	
Communication with Carthagena and Barranquilla (Columbia)	Dec. 8, 1900	
Trinidad-Demerara No. 1	Aug. 27, 1901	
Dominica-Martinique	May 8, 1902	
Dominica-Guadeloupe	Nov. 4, 1902	Dec. 12
St. Lucia-Martinique	May 8, 1902	
Guadeloupe-Martinique	May 9, 1902	
Santa Cruz de Teneriffe to Tejita de Teneriffe	July 4, 1902	
Puerto Plata-Martinique	July 10, 1902	
Guantanamo-Mole St. Nicholas	Aug. 4, 1902	
Cayenne-Pinheiro	Aug. 13, 1902	
St. Lucia-St. Vincent	Sept. 19, 1902	
Reissi-Issa	Oct. 22, 1902	
Reissi-Yemani	Oct. 22, 1902	
Cadiz-Teneriffe	Nov. 3, 1902	
Landlines :—		
Route *via* Hanekin on Persian territory	Feb. 24, 1900	
Communication with Tientsin and Taku *via* Helampo	July 18, 1900	
Communication with Maranham	Sept. 19, 1902	
Rome-Constantinople	Dec. 13, 1902	

CONTRACTS OPEN AND CLOSED.

OPEN.

Barrow.—January 5th. Two 250-kw. steam generators, switchboards and piping. See "Official Notices" December 5th.

Blackpool.—December 24th. Poles, arms and brackets, cables, trolley wire, bonds, insulators, &c. See "Official Notices" December 12th.

Brighton.—December 23rd. Tramway tracks, bonding, and wood paving. See "Official Notices" November 28th.

Bristol.—January 6th. Surface condensers for Avonbank station. See "Official Notices" to-day.

Brockley.—December 22nd. The Parish Council invites tenders for the lighting by electricity of the streets of Brockley Village. Mr. E. J. Wyatt, Clerk to the Council.

Brussels.—December 24th. The Belgian Post and Telegraph Administration want tenders for galvanised iron wire, and telegraphic and telephonic instruments.

Bucharest.—December 24th. The Department of Posts and Telegraphs want tenders for 50,000 kilos of galvanised steel wire of 2 millimetres thickness.

Buluwayo.—February 26th, 1903. Establishment and working of an electric tramway. See "Official Notices" Nov. 21st.

Canterbury.—January 1st. Tell-tales, clocks and bells. See "Official Notices" to-day.

Clacton.—December 22nd. Two Economic boilers, piping; two 100-kw. steam dynamos, balancer and boosters; switchboard; cables, &c.; accumulators; crane. See "Official Notices" November 14th.

Devonport.—December 29th. Overhead equipment for Corporation tramways. See "Official Notices" December 5th.

France.—January 1st. The Prefectural authorities of the department of Calvados are inviting projects until January 1st, 1903, for the construction and working of an electric tramway, for the transport of passengers and goods between Trouville and Honfleur, a distance of about 10 miles. Particulars may be obtained from, and proposals are to be sent to, La Prefecture de Calvados, Caen.

Glasgow.—January 5th. 100 electric motor equipments and spare parts. See "Official Notices" December 12th.

Hebden Bridge.—December 22nd. Gas engines, dynamos, booster and balancers, battery, switchboard, crane and cables. See "Official Notices" December 5th.

Lowestoft.—January 7th. Motor cars, trucks, motors, and equipments, and track sweeping and watering car. See "Official Notices" December 12th.

Newport (Mon.).—Messrs. G. F. Lovell, Monmouth Confectionery Works, Newport, require an electric lighting installation. Particulars of C. D. Copland, M.I.E.E., Westgate Chambers, Newport.

Oldham.—December 30th. Cables, joint boxes, &c. See "Official Notices" to-day.

Partick.—January 6th. Arc lamp columns, arc lamps, mains, &c. See "Official Notices" to-day.

Roumania.—December 24th. The Roumanian Post and Telegraph authorities in Bucharest are inviting tenders for the supply of 50 tons of galvanised steel wire 2 mm. diameter.

Salford.—December 20th. 1,140 yds. of lead-covered cable. See "Official Notices" December 12th.

Spain.—December 26th. The municipal authorities of Trujillo (Caceres province) are inviting tenders until December 26th for the concession for the electric lighting of the town during a period of five years. Particulars may be obtained from, and and tenders are to be sent to, El Secretario del Ayuntamiento de Trujillo (Caceres).

Stalybridge.—January 5th. Cables, telephone and test wires, high and low tension switchboards for main and sub-stations. See "Official Notices" December 12th.

Stepney.—January 15th. 500-kw. steam dynamo. See "Official Notices" to-day.

Stoke-upon-Trent.—January 14th. Destructor, boilers, pumps, conveyor, economiser, steam dynamos, balancer, boosters, switchboard, battery, mains, &c., crane, and workshop machinery. See "Official Notices" December 12th.

Sunderland.—January 2nd. Lancashire boiler, with fittings, &c. See "Official Notices" December 5th.

Swansea.—January 8th. Wiring and fittings for new harbour offices. See "Official Notices" to-day.

Swindon.—December 29th. Wiring of Town Hall. See "Official Notices" December 12th.

Wallasey.—January 15th. Steam dynamo, Lancashire boiler, condensing plant and cooling tower. See "Official Notices" December 5th.

Wigan.—December 29th. Switchboard extensions, and supply of cable. See "Official Notices" December 12th.

Wellington, N.Z.—January 21st. Supply and installation of all material, including power house equipment, overhead work, track work, feeders, tramcars, &c., for tramways. See "Official Notices" December 12th.

CLOSED.

Ashton-under-Lyne.—The T.C. has accepted the following tenders:—Messrs. Chamberlain & Hookham, Ltd., Birmingham, for altering meters to 240 volts; Messrs. G. F. Milnes & Co., of Hadley, for telescopic tower waggon, with revolving platform, and the necessary tools.

Bradford.—The tenders of the undermentioned firms have been accepted for the year's supply of electric motors to the Corporation:—Keighley Electrical Engineering Co., Ltd., 30 4½-h.p.; Rhodes Electrical Manufacturing Co., 24 7-h.p.; Phœnix Dynamo Manufacturing Co., 15 10-h.p.

The B.T.H. Co., of Rugby, has secured an order from the Corporation for 11,000 B.T.H.-Edison incandescent electric lamps, this being a repeat order to one received three months ago from the same Corporation for a similar quantity of B.T.H. lamps.

Burton-on-Trent.—The T.C. on December 10th accepted the tender of Messrs. R. W. Blackwell & Co., Ltd, of London, for overhead equipment of the tramways at £5,621; and that of the British Insulated and Helsby Cables, Ltd., of Liverpool, for electric light mains for the tramway service, at £1,183.

Bury St. Edmunds.—The T.C. has accepted the following tenders:—Messrs. John Fowler & Co. (Leeds), Ltd., for a Bellis engine and Fowler's dynamo, at £964; Messrs. Cole, Marchent and Morley, for surface condensing plant and oil trap, at £484; Mr. H. G. Frost, extensions to generating station, £442.

Chesterfield.—The T.C. has ordered certain engines, &c., from the British Westinghouse Co., at £2,999.

Derby.—The Derby Co-operative Society have decided to instal Willans engines for direct coupling to dynamos of Mather and Platt's make for supplying power to their new premises.

Durham.—The owners of the Binchester Colliery have decided to instal a compound 360-h.p. Willans engine for direct coupling to a multi-phase generator of the A.E.G. type. This plant is to be used for supplying power to motors in their colliery.

Finchley.—The U.D.C. have accepted the following tenders in connection with their electric lighting scheme:—Boilers, R. Hornsby & Sons, Ltd., £1,295; engines and dynamos, Sunderland Forge Co., Bellis-Sunderland Forge sets with Carrick and Ritchie crane, £2,264; cables, &c., Callender's Co., £10,107. The three lowest tenders for storage batteries were £850, £908 and £970 by German firms, and the lowest tenders by English firms were £1,290 and £1,295. The U.D.C. has therefore authorised the electrical engineer, Mr. Calvert, to visit the works in Germany before any tender for batteries is accepted.

Gravesend.— The T.C. has accepted the tender of Messrs. Galloways, Ltd., Manchester, for the supply of a boiler for the electricity works, at £540.

Heckmondwike.—The U.D.C. has accepted the tender of the Stirling Boiler Co. for the supply of a boiler for the electric light works.

London.—The London County Council received the following tenders for the wiring, fittings and bellwork at the Fire Brigade Stations mentioned:—

Clapham Station.

	£	s.	d.
F. J. Coleby & Co. .. .. (accepted)	233	0	0
Southern Electrical Installation Co.	320	3	0
Wenham & Waters, Ltd.	333	15	0
E. Thornton	324	16	0
J. Bakewell & Co.	328	18	0
Barlow Bros. & Co.	340	0	0
Lawrence & Co.	340	0	0
Nunn, Watts & Co.	340	0	0
W. Mossop & Co.	387	16	0
A. E. Bennett & Co.	394	10	0
Jackson Bros.	415	18	6
W. G. Murrin	554	10	0

Highbury Station.

	£	s.	d.
F. J. Coleby & Co. .. .. (accepted)	176	5	0
A. H. Marshall	230	0	0
Nunn, Watts & Co.	235	0	0
Barlow Bros. & Co.	250	0	0
Southern Electrical Installation Co.	257	0	0
Lawrence & Co.	260	0	0
J. Bakewell & Co.	275	0	0
Wenham & Waters, Ltd.	281	10	0
W. Mossop & Co.	288	12	0
H. Sutton & Co.	290	9	7
Jackson Bros.	302	6	0

Lourenço Marques.—Messrs. Macartney, McElroy and Co. are stated to have secured the contract for a complete system of electric tramways, including power station, overhead line, rolling stock, &c., for Lourenço Marques at a cost of £100,000.

Newcastle-on-Tyne.—We have already announced that the tender of Messrs. Victor Coates & Co., Ltd., of Belfast, has been accepted for the new engine for the Newcastle-upon-Tyne electric tramway extension. The engine is to be of the firm's well-known triple vertical type, and is to be capable of a daily load of 3,000 I.H.P. This order follows the two sets of 1,000 I.H.P. each, already started to work in the same station, a significant fact.

Newport (Mon.).—The Corporation has ordered cable for tramways extension from Messrs. W. T. Henley's Telegraph Works, Ltd., at £605.

Salford.—The Corporation has accepted the following tenders for the electricity works:—Howard Conduit Co., Ltd., of Manchester, for 450 yards of patent waterproof covered cable at £166 17s. 6d., with 3d. per yard extra for supervision of laying; Messrs. Lloyd & Lloyd, Ltd, for wrought-iron pipes and bends; the Staveley Iron Co. for cast-iron pipes and bends; the Howard Conduit Co., Ltd., for asphalt troughing; Messrs. Chamberlain and Hookham, Ltd, for continuous current meters.

South Africa.—According to the *British and South African Gazette*, the Westinghouse Co., of Pittsburg, have secured an order for six electric locomotives and two steam turbo-generators; the same company are to lay down a complete tramway system for the De Beers mines.

Southport—Liverpool. — Messrs. Yates & Thom, of Blackburn, have secured the contract for the supply of engines and boilers to the Lancashire and Yorkshire Railway Co., for the generating station in connection with the electrification of the Southport and Liverpool line.

Warrington. — The T.C. has accepted the tender of Messrs. Johnson & Phillips, of Old Charlton, for the supply of cables for the next 12 months, at £1,115.

Wigan.—The Electric Light and Tramways Committee has accepted the tender of Messrs. Hurst, Nelson & Co., for the supply of 18 single-deck bogie tram cars with their own trucks, the British Thomson-Houston Co.'s equipments.

FORTHCOMING EVENTS.

Friday, December 19th.—At 8 p.m. Electro-Harmonic Society. Smoking Concert at the Holborn Restaurant. The chair will be taken by Mr. James Swinburne, President of the I.E.E.

At 8 p.m. Institution of Civil Engineers. (Students' meeting.) Paper to be read on "Electricity Supply from Double Current Generators," by Mr. P. R. Wray.

Tuesday, December 23rd.—At 8 p.m. Institution of Civil Engineers. Paper on "Electric Automobiles," by H. F. Joel.

Saturday December 27th.—At 3 p.m. Royal Institution. Lecture I., by Prof. H. S. Hele-Shaw, F.R.S., "On Locomotion: On the Earth—Through the water—In the air."

NOTES.

Christmas Holidays.—Next week the Electrical Review will be published on Wednesday morning instead of Friday. It will, therefore, be necessary for us to proceed to press much earlier than is our custom. Will our friends kindly take note that matter should reach these offices as follows:—

Editorial Matter (Articles, Correspondence; News, &c.) must be received by Monday, mid-day, at latest.

Advertisement Matter.—New copy and alterations to existing advertisements by Saturday morning, December 20th. Official notices and small advertisements, by noon, on Tuesday, December 23rd.

The Nernst Lamp.—In the action brought against the Allgemeine Elek-Gesellschaft as to their patent concerning the Nernst lamp, the Reichsgericht has dismissed the plea of nullity against Nernst's first patent, cancelling the judgment of the Patent Office. The validity of the patent is thus fully maintained, the plaintiff being condemned to defray the expenses.

Boiler Explosions Acts.—The twentieth report on the working of the Boiler Explosions Acts, 1882 and 1890, which covers the year ending June 30th last, has just been issued. During that period 51 preliminary inquiries and 17 formal investigations have, under the Acts' provisions, been held. The report includes an abstract of all the cases dealt with and a classification of the causes of explosions and the types of the boilers which failed. The number of lives lost within the scope of this report was 30, and this corresponds very closely with the average of the past 20 years. —The *Times*.

The British Electrical Friendly Society.—The first annual general meeting of the British Electrical Friendly Society was held on Monday last, the 15th inst., at Essex Hall. Mr. Garcke, chairman of the Central Committee, presided, and those present included delegates from the 23 operating branches of the Society. In moving the adoption of the report and accounts, the chairman drew attention to the fact that the high rate of sick pay granted by the Society rendered it doubly necessary for every member to exercise the greatest vigilance in regard to sick claims. The motion was seconded by the Rev. J. Frome Wilkinson, one of the trustees. The election of new representatives of the men upon the Central Committee then took place, and after a lengthy and instructive discourse by the delegates upon various points connected with the detailed working of the Society, the proceedings terminated. The delegates were then entertained by Mr. Garcke at Anderton's Hotel. After tea further speeches were made, in which stress was laid upon the fact that the rules had been drawn up with a view of ultimately extending the scope of the Society so as to include a provident fund and a pension fund. The membership of the Society is now nearly 1,500, and it is expected that several large new branches will be opened in the course of the next few months.

The Westinghouse Works: Strained Relations with Workpeople.—Our Manchester correspondent writes:—"For some time past there has been considerable friction between the local branch of the Amalgamated Society of Engineers and the officials of the British Westinghouse Co., at Manchester, on the questions of payment for overtime and the number of hours constituting night shifts. According to the demand of the Westinghouse Co., 47½ hours have to be made in five nights of 9½ hours, which is contrary to the custom of the district, as recognised by the Amalgamated Society of Engineers, which is 45 hours, made up of five nights of 9 hours each, and paid for at the same rate of wages as for 53 hours in the day. So far, the British Westinghouse Co. have ignored all the representations put forward by the local officials of the Amalgamated Society, who contend that they cannot recognise, so far as their members are concerned, any special conditions for the British Westinghouse Co. which would give them an unfair advantage over other engineering employers in this district; and already there is talk of a withdrawal of the Amalgamated Society's members from the Westinghouse works, unless they are paid the recognised rates. The matter is to be considered this week at a meeting of the Amalgamated Society's members who are in the company's employ, and a decision one way or the other is expected to be arrived at."

Personal.—On Saturday last, December 13th, Mr. P. W. d'Alton, chief engineer of the Central London Railway, was the recipient of a testimonial in the shape of a very handsome silver tea and coffee service. The presentation was made by Mr. E. M. Malek, chief assistant engineer, on behalf of over 400 members of the official and general staff of the Engineering Department, who wished Mr. d'Alton every success in his new sphere of action with Messrs. Dick, Kerr & Co.

Mr. R. W. Phillips has been presented with a dinner service and set of carvers by the Bromley and Croydon staffs of the National Telephone Co. on his marriage.

Last Saturday evening Mr. C. H. Garland was presented with a cheque for £72, in recognition of his work during the last ten years as secretary of the Postal Telegraph Clerks' Association (London Branch). The presentation included a donation of 250 francs from French telegraphists.

The Shah has conferred upon Mr. Jules de Meray, the chairman of the Sir Hiram Maxim Electrical and Engineering Co., the rank of Commander of the Order of the Lion and the Sun. His Imperial Majesty, in August last, visited the Maxim Electrical Lamp Works, at Gillingham Street, London.

We learn from a contemporary that Mr. F. H. Mills, electrical engineer to the Natal Government Railways, is now in England on six months' furlough. Before leaving for home, he was presented by the electrical staff with a handsome dressing case and silver spirit flask.

Mr. Jul. H. West, has opened an office at Halleschestr, 20, Berlin, S.W., where he will practice as a consulting engineer on all matters relating to telephony, telegraphy, electrical signalling, &c. Patent work and technical translation duties will also be undertaken.

Yorkshire College Engineering Society.—On Monday, December 8th, Mr. H. Ade Clark lectured to the members of this society on "The Diesel Oil Engine."

Appointments Vacant.—An engineer-in-charge for Belfast at £2 5s. per week; at Erith, an outside assistant engineer at £104 and a shift engineer at £91; a chief assistant electrical engineer at £2 10s., an electrician-in-charge at £2, and a junior electrician-in-charge at £1 10s., for Hornsey; a senior electrical engineer for Gibraltar at £300; mechanical electrical engineer for Croydon Mental Hospital at 35s.; a shift engineer for Eastbourne (£104 per annum); shift engineer for Perth (30s.). See "Official Notices" to-day.

Edwards Air Pump.—In our article on the Cleckheaton electricity works last week, we mentioned that the condensing plant was supplied by Messrs. Alley & MacLellan; we should add that the air pumps are of the Edwards patent type.

High-Speed Electrical Generating Plant. — A paper was read before the Institution of Civil Engineers on December 2nd, on the above-named subject, by Mr. T. H. Minshall. The paper was written with the object of comparing the relative advantages of high and low-speed combinations for the purpose of generating electricity. Causes which limited the increase of speed in engines and dynamos were first considered. The advantages of various types of valve-gear were then discussed, also the reasons for discarding poppet and flat slide-valves, and the troubles attending the use of the latter. The next point considered was vibration in single, two or three-crank engines, some account being given of the various means by which the trouble had been overcome. The stresses due to inertia of the moving parts were then dealt with, various figures and diagrams taken from actual practice being given. The author showed that the speed of continuous-current combinations was as a rule limited by that of the dynamo, but that the speed of alternators, on the other hand, was generally limited by that of the engine, and could be made considerably higher with advantage. Tables were added giving the comparative cost of high and low-speed electrical machinery in actual practice. A comparison was then made of the governing of the two types of engines, it being shown from figures and diagrams taken from machines in actual operation that the speed and voltage regulation (both temporary and permanent) of high-speed machinery on variable loads could be made as close as was required. Some attention was given to the question of parallel running, the advantage being shown to be in favour of high-speed apparatus; the results of some experiments made to measure the variation of the crank-effort were also appended. Details of a large number of recent tests of mechanical efficiency and steam consumption of various types of engines were given. The effect of clearance upon the economy was referred to, the results of some special experiments with artificial clearance being presented to show that in high-speed engines at least the loss from this cause was less than was usually believed. The use of superheat was then discussed, with a number of examples from actual practice. Re-heaters and jackets were next dealt with, it being shown that the latter as a rule were of little value in high-speed engines. The efficiency of expansion and cut-off governors was compared in the light of certain special experiments made for the purpose, it being shown that the difference in economy was less with high-speed than with low-speed engines; after which followed a discussion of the comparative merits of triple and compound engines. Numerous examples of recent economy tests from combined sets were then given at full, light and variable loads, as well as the results of some special experiments made to compare the consumption upon steady and variable loads. Figures dealing with the repairs and attendance in various central stations were given. Finally, the author considered the capital cost, and the bearing which the load factor had upon the latter.

Electricity in the Manufacture of Glass.—A method of melting glass by means of alternate currents is described in *Tekn. Tidsskrift*. The process is based on glass in the molten state becoming capable of conducting electricity. A certain amount of glass is fused, and the fluid mass is inserted in an alternate-current circuit, when on account of the resistance the molten glass offers to the current, the electrical energy is converted into heat, the melted mass thus becoming still more highly heated. On adding suitable amounts of raw material, the heated glass mass giving off heat to the latter fuses it also to glass. The fluid glass may be taken away progressively, provided enough be left to conduct the current. Both the introduction of raw material and the removal of the manufactured glass thus going on without intermission, the process may be made perfectly continuous.

New Insulating Material.—A process has been patented by the E.A.G. vorm. Schuckert & Co. for impregnating asbestos with inorganic precipitates insoluble in water, such as are formed between the fibres by the chemical conversion of suitable salts or oxides. This insulator after drying compares very favourably with the mica or press-board at present in use, and it is preferable to the latter and to organic insulators in general, as in the case of its being pierced no channel of conductive carbon is produced. It is claimed that this material will stand with perfect safety even very high pressures, and possesses an insulating power very much higher than any material so far in use.

Electricity v. Soap.—An electrical washing machine has, according to the Buda-Pesth papers, been invented by Josef Nagy, of Szegedin. With this machine the use of soap is dispensed with, the electric current being intended to take away any stain or grease. This machine is said to be capable of washing as many as 200 or 300 pieces of linen without the assistance of a man being required.

THE CENTRAL STATION ENGINEER.

Mr. O. F. Francis, of Aldershot, has been appointed burgh electrical engineer in connection with the tramways and electric lighting undertakings of the Kirkcaldy Corporation. There were 67 applicants for the post. Mr. Francis served his time at Sandycroft, and later was assistant engineer at Bootle.

Mr. Du Verge has resigned the position of assistant engineer at the Bristol Corporation electricity works.

Councillor Barlow, at the request of the Ashton-under-Lyne Electricity Committee, has given notice that at the next meeting of the T.C. he will move that the salary of Mr. A. N. Appelbee, electrical engineer, shall be increased by £100 a year as from November 1st last, Mr. Appelbee having consented to continue his services for not less than two years.

Mr. C. M. Henderson, assistant engineer at Dee Village electricity works of the Aberdeen Corporation for three years, has left to enter the service of the British Westinghouse Co. His friends at Aberdeen presented him with an illuminated address and album of photographs on his departure.

Mr. Alexander Petty, on leaving Bristol to take up an appointment in the Twickenham E.L. Department, has been presented by a number of friends with a silver-mounted umbrella and an illuminated address.

Worksop U.D.C. has appointed Mr. H. A. Best, of Bradford (Yorks), as assistant electrical engineer.

Mr. William Burr, late of Pinkston Power Station, Glasgow, has been appointed station superintendent at Reading.

NEW COMPANIES REGISTERED.

Fife Electric Power Co., Ltd. (65,736).—This company was registered on December 13th, with a capital of £30,000 in £10 shares, to produce, store, supply and sell electrical energy and power and electricity of all kinds for public and private lighting, traction, power, heating, chemical, trade, manufacturing and other purposes in Fife or elsewhere. The first subscribers (each with one share) are:—R. W. Stewart, Dunfermline, bleacher; R. Russell, Markinch, paper maker; R. S. Portheim, Scottish Liberal Club, Edinburgh, engineer; R. H. Sankey, 32, Grosvenor Place, S.W., Lieut.-Gen., K.C.B., R.E.; A. R. Holland, Leesons, Chislehurst, gentleman; T. O. Callender, West Heath House, Abbey Wood, Kent, engineer. No initial public issue. The number of directors is not to be less than five nor more than ten; the subscribers are to appoint the first. Remuneration as fixed by the company. Registered office; 5, Great George Street, Westminster, S.W.

Halsey Electric Generator Co., Ltd. (5,232).—This company was registered in Edinburgh on December 10th, with a capital of £2,000 in £10 shares, to carry on the business of manufacturers and dealers in electric batteries, motors, dynamos, and other electrical machinery, appliances, plant, and goods of every kind. The first subscribers (each with one share) are:—James C. Haydon, Jesseville, Lucyerne, Pennsylvania, U.S.A., manufacturer; Clement R. Woodin, Berwick, Columbia City, Pennsylvania, U.S.A., manufacturer; William S. Halsey, 49, 44th Street, New York, U.S.A., engineer; Henry Halsey, 49, 44th Street, New York, U.S.A., advocate; Howard H. Williams, 115, Park Avenue, New York, U.S.A., advocate; William Hogg, 9, Wardie Crescent, Edinburgh, merchant; and Robert Hunter, 2, North Fort Street, Leith, agent. The first directors are C. R. Woodin, J. C. Haydon, and H. Halsey. Registered office, 38, York Place, Edinburgh.

SUPPLY STATION ACCOUNTS.

Islington Borough Council Electricity Accounts.

The accounts of the Islington undertaking for 1901 are the second issued since the transfer from Vestry to Metropolitan Borough Council, and as the previous accounts covered a period of 15 months, it is impossible to make any useful comparisons between the figures for the two nominal years given below. Under the late Vestry the financial year, or at least the period covered by the annual accounts of the electricity department, ran from January to December, whereas now, in order that the period should be coincident with the general rate accounts, it is from March to March. The heavy capital expenditure on works and extensions, which was unproductive in the previous accounts, was partially, at least, revenue-earning during the last period covered by our analysis, and the policy of the Council in fostering a day load has had some effect, although we do not suppose that Islington can expect to vie with St. Pancras or Shoreditch in this respect.

General Statement.

	1900.	1901.	Inc.
Total capital expenditure ...	£322,334	£365,843	£43,509
Number of units sold	2,324,057	2,186,044	—138,013
Total maximum load, K.W. ...	1,419	1,826	407
Gross revenue	£42,425	£41,334	—£1,091
Gross expenditure...	£29,567	£24,640	—£4,927
Gross profit	£12,858	£16,694	£3,836
Average price per unit sold ...	4·31d.	4·45d.	+·14d.

The prices charged remained at 7d. and 4d. on the sliding scale, with a power rate of 2d. per unit. The price for street lighting was 3½d. per unit, which included all charges for the provision and maintenance of the public lighting mains, lamps and columns. As Mr. Albert Gay, the borough electrical engineer, mentions in his report, the improved figures are certainly due in part to the increase in the number of units for private supply as compared with the public lighting.

The change is quite obvious:—

	Private supply. Units.	Revenue.	Public lighting. Units.	Revenue.	No. of public lamps.
1899	686,225	£15,254	660,212	£9,628	333
1900	1,188,821	£25,259	1,135,236	£16,556	398
1901	1,252,595	£26,962	933,449	£13,612	400

This accounts for the slightly higher average price received per unit sold.

Revenue Statement.

	1900. 15 months. Gross.	Per unit.	1901. 12 months. Gross.	Per unit.	Inc.
Sale of energy	£41,744	4·31d.	£40,557	4·45d.	+·14d.
Meter rents	581	·06d.	656	·08d.	+·02d.
Sale of lamps, &c.	—	—	—	—	—
Rent received, bank interest and fees.	100	·01d.	121	·01d.	·00d.
Gross revenue ...	£42,425	4·38d.	£41,334	4·54d.	+·16d.

The fall in the price of coal, coupled with other economies, has brought about a substantial decrease in the working costs. Had not the extensions of plant, coincident with the opening of a new boiler house, rendered it necessary to employ additional staff, the item of wages would probably have been further reduced. The total cost is now below 2¾d. per unit.

Cost of Production.

	1900. 15 months. Gross.	Per unit.	1901. 12 months. Gross.	Per unit.	Inc.
Coal	£13,633	1·41d.	£10,617	1·17d.	—·24d.
Oil, waste, wages, engine room stores and carbons.	3,034	·31d.	2,870	·32d.	+·01d.
Salaries and wages incurred in generation and distribution and attending street lamps.	5,551	·58d.	5,036	·55d.	—·03d.
Repairs and maintenance of engines, boilers, dynamos, buildings, and repairs to public lamps.	2,338	·24d.	1,572	·17d.	—·07d.
Works costs ...	£24,556	2·54d.	£20,095	2·21d.	—·33d.
Rent, rates and taxes ..	1,425	·15d.	1,431	·16d.	+·01d.
Management expenses, salaries of managing engineer, secretary, clerks, &c.	2,410	·25d.	2,137	·23d.	—·02d.
General establishment charges, stationery and printing, law charges and insurance.	1,128	·11d.	937	·10d.	—·01d.
Other expenses, repairs to property.	33	·00d.	40	·00d.	·00d.
Total costs ...	£29,567	3·05d.	£24,640	2·70d.	—·35d.

The deficit of £1,027 for 15 months' working (including two winter quarters) has been turned into a profit of £1,402 on 12 months' working, and this with an increased capital charge, including interest and redemption of £1,354, and an output of 138,000 units less than in the previous period. The gross profit being £3,836 more, enabled the extra £1,407 financial charges to be met with a balance of £2,429 over, and this turned the loss into a profit as given below:—

Profit Statement.

	1900. 15 months.	1901. 12 months.
Interest on loans and deposits	£9,099	£10,781
Sinking fund for repayments	4,786	4,511
Net profit carried forward	—1,027	1,402
Gross profit	£12,858	£16,694

CITY NOTES.

Isle of Thanet Electric Tramways and Lighting Co.

Lord Arthur Butler presided at the meeting of this company, held at Salisbury House on Tuesday, and in moving the adoption of the report as printed in our columns last week, called attention to the fact that the revenue account dealt with 18 months (to September 30th, 1902), though it was only at this time last year that the present proprietors came into existence, the tramways having been carried on up to that date by the contractors who constructed and equipped them. The general balance-sheet had, however, been brought down to the end of November. The item of £9,228 for sundry creditors, included about £8,000 balance due to the contractor. The item of £9,261 for extra works was made up of details not included in the original contract, and sundry plant and materials required by the company and taken over by them. The item included some expenditure which could not have been anticipated, such as the extra size of the sub-station at Margate; also provision of water supply by means of their own wells, thus saving hundreds of pounds per annum. In regard to the item of £4,524 for additional electrical equipment and traction cables, this expenditure had been incurred in the further development of the heavy summer traffic. It was thought advisable to add auxiliary cable to prevent stoppage of the traffic through any unforeseen damage to the existing cables. The £2,277 included the purchase of freehold land for sub-stations at Margate and Ramsgate, and also car shed accommodation at the power station. When the line was opened, as traffic developed, the 40 cars supplied under the contract were found to be inadequate; 20 new ones were therefore ordered, 10 of which had been delivered and were running last summer, and the other 10 would be ready for next season. The accounts included £12,045 for additional rolling stock. Owing to the very sharp nature of the curves and the steep gradients, it was found necessary to remodel the trucks of the cars originally delivered. The directors were of opinion that the cost of this work was not a legitimate charge against one year's revenue, and they decided to charge it to a special car account, and had this year written off £1,000, one-half of the amount. The item for compensation was an exceptional amount, £2,600, and nearly the whole of it arose from the regrettable accident which occurred more than a year ago. The company was now its own insurer up to £500 for any one accident, and it had effected a policy at Lloyd's for insuring themselves against large disasters in future. The accidents which had occurred since the serious one referred to had been of a very trivial nature. The oil lamps on the centre poles had given place to the electric lamps. Owing to the high cost of carriage upon coal bearing such a large proportion to the first cost of the coal, they had bought the best quality of steam coal, and by the use of this they saved in the quantity required. Under an old Act the company had to pay 1s. per ton toll on every ton of coal delivered at the power station. The maintenance of their rolling stock must always be an expensive matter because of the sharp curves and steep gradients involving constant use of the brakes and great wear and tear of wheels and rails. These charges as well as that of the permanent way maintenance must always be in excess of those for a tramway traversing a flat district. Exceptional difficulty was experienced in making arrangements for the traffic of a district such as the Isle of Thanet, for there was great pressure during the summer, and in the winter the traffic was very small. This involved the employment of a large staff during a comparatively small part of the year; this had to be reduced when the summer season was over, and it was not an easy matter to arrange. The passengers carried from October, 1901, to March, 1902, were 1,233,000; but in the summer months from April to September last they were 3,339,442, or a difference of over 2,000,000. The company experienced considerable loss on last winter's traffic owing to want of experience of the traffic required in Margate and Ramsgate. Profiting by last year's experience they were now working the traffic at a reduction varying from £70 to £100 per week as compared with the corresponding period last year, while the receipts were about the same. After referring to the bad effect of the severe weather, and of the postponement of the Coronation which interfered with holiday makers' arrangements, the chairman said that they hoped that the supply of current for lighting purposes in the winter would make up for the lessened traffic receipts. The installation of the public lighting at Margate had to be postponed owing to arrangements with the Corporation not being completed.

The directors thought it prudent to carry the balance of £12,828 forward this year; this time next year they would be in a better position to judge as to what distribution they could offer.

Mr. HY. BROWN seconded the motion, and mentioned that if they got a fair season next year they should earn a dividend; it might not be much, but he believed it would be over 2 per cent.

A discussion then ensued in regard to the various items in the accounts, and these having been replied to by the chairman, the report was approved.

Mr. Brown was re-elected a director, but Mr. Gardner was unable to attend the meetings through indifferent health, so had retired.

The auditors were also re-elected, and a vote of thanks to Lord Arthur Butler terminated the proceedings.

India-Rubber, Gutta-Percha and Telegraph Works Co., Ltd.

MAJOR DARWIN presided at the meeting of this company held at 106, Cannon Street, E.C, on Tuesday last, and in moving the adoption of the report, which appeared in our last issue, he said that they were able to continue to recommend a distribution which, with the interim dividend of June last, made 10 per cent. for the year. The chairman of the last meeting said that the company had secured a contract for the making and laying of a cable to connect San Francisco with the Sandwich Islands. Their cable steamer *Silvertown* had arrived at San Francisco and had landed the Californian shore end, and was now engaged laying to Honolulu, about 200 miles being payed out. They hoped that the cable would be able to commence working before this month terminated. Mr. J. W. Mackay, who had a large interest in the Commercial Pacific Cable, did not live to see the completion of the work which he had made his own, and which he believed would be of great value to California. The *Buccaneer* cable steamer was now employed on cable repairing on the West African coast. The company's general business showed a falling off in value, but not so much in bulk. Lower selling prices were responsible for this to some extent, but there was also some shrinkage in business. The board were alive to the necessity of taking every advantage of new lines of business as opportunity arose, and should the depression in general lines not pass away, as it had done on several previous occasions, those new lines would quite cover any deficiency that might arise. It was possible that the board might have to increase the accommodation at Silvertown to enable them to handle goods with greater dispatch than at present. They would appreciate the necessity of those changes if he informed them that they had in their pay about 4,200 employés, and the number was ever growing.

Mr. SCOTT seconded the adoption of the report, and after a few questions had been asked and satisfactorily answered, it was carried unanimously.

Extraordinary general meetings followed, at which resolutions were passed enabling the company to hold interests, &c., in other companies.

South Lancashire Electric Traction and Power Co.

THE report of the directors to October 31st, 1902, reads as follows:—

During the period covered by the report, the constructional work has proceeded with as much expedition as circumstances permitted. Some delays occurred in the conduct of negotiations with various local authorities, in the acquisition of property required for road widening, and in the completion of engineering contracts. These difficulties have now been almost entirely overcome. Several sections of the tramway system have been open for traffic, and other sections are in an advanced state and nearly ready for public use. The section from Knotty Ash to Prescot (establishing communication between Liverpool and St. Helens) was finished in January last, and passed by the Board of Trade in April. It was not until the end of June that the Corporation of Liverpool joined up the City lines to those of this company. Since the line has been working, the traffic receipts have been highly satisfactory. The next section taken in hand (covering about 25 miles of track) extended from Bolton through Atherton and Leigh to Lowton, and from Tyldesley through Atherton to Hindley, and thence through Ashton-in-Makerfield to Haydock. The construction was begun in October, 1901, but the causes already indicated considerably delayed the progress of the work. The Bolton—Lowton and the Tyldesley—Atherton sections were passed by the Board of Trade September 25th, 1902, and the cars commenced to run on October 20th. The directors believe that the service has given entire satisfaction to the people of the district. Considering the inclement weather, the receipts have been good. The further sections joining up the system with St. Helens at Haydock are in a forward state, and will be ready for use in a few weeks' time. There will then be in operation a direct tramway service between Liverpool and Bolton, *viâ* St. Helens and the company's trunk line. The generating station and car shed at Atherton are finished as regards buildings necessary for the present requirements. The greater part of the electrical equipment has been installed and is at work. The sub-station at Hindley is making good progress. The South Lancashire Tramways Co. has given notice of an application to Parliament in the ensuing Session for a Bill to amend and enlarge some of the company's powers. The directors beg to present the balance-sheet showing the company's position on October 31st, 1902, duly audited. No profit and loss account is presented, as the company's system was in partial operation too short a time to make such an account useful or informing. On future occasions a full statement of revenue and expenditure will, of course, be presented to the shareholders periodically. In accordance with clause 93 of the articles of association, Mr. Edwin Adam retires at the ordinary general meeting, and is eligible for re-election. Messrs. Chalmers, Wade & Co., the auditors, also retire, and are eligible for re-election.

Sir J. A. Willox, M.P., presided at the ordinary general meeting of shareholders held at Liverpool on Friday. When moving the adoption of the report and balance-sheet, the chairman said that the carrying through of the scheme had involved enormous difficulties and many complications. The network of tramways which the company contemplated passed through the areas of a large number of local authorities, and he was bound to say that those local authorities did not always take a broad-minded and liberal view of public policy. They had been less constrained to promote the interests of the general community in the matter of cheap transport of passengers and goods, than in striving to secure to their immediate locality special advantages for themselves at the general expense. The chairman spoke in detail of the progress of the works. The first constructional work was that of the light railway between Liverpool and Prescot. The Liverpool Corporation had not linked up their lines from Old Swan to Knotty Ash until June, but it had been done, and the through service was begun at the end of June. The next section had Bolton for its base. Lines had been constructed and a regular service had been established between Bolton and Lowton, and between Tydlesley and Atherton on October 20th. The line from Atherton to Hindley had been completed and awaited official inspection by the Board of Trade. The extension from Hindley to Haydock was also in hand, and there was reason to believe, would be in operation early in the new year. The company would then have a direct and continuous system of tramcars running from Bolton to Liverpool. Power for operating the system was obtained, as far as the section beyond St. Helens was concerned, from a large generating station at Atherton. The expense of generating promised to be exceptionally low. As regards traffic there were future possibilities far beyond anything contemplated for a mere passenger service. There was the goods traffic; there was the parcels traffic; and there was the supply of electrical power for manufacturing and industrial purposes.

The motion was seconded by Mr. E. R. MUSPRATT, and the report and balance-sheet were unanimously adopted.

Mr. E. ADAM, a retiring director, was re-elected, and Messrs. Chalmers, Wade & Co. were re-appointed auditors to the company.

The Bastian Meter Co., Ltd.

THE directors' report, submitted to the shareholders at the meeting held at Kentish Town yesterday, reads:—

Your directors have the pleasure to submit to you the fourth annual statement of accounts for the 13 months ending February 28th, 1902, and also the profit and loss account for the following six months ending August 31st, 1902. The sole selling agency of the British Electric Meter Co., Ltd., was not cancelled until January 19th, 1902, and during nearly the whole of the first period of 12 months the company's operations were considerably hampered by the unsatisfactory nature of that arrangement, and were disorganised owing to the negotiations for its termination. The loss of £656 8s. 10d. may fairly be attributed to these causes. A profit of £930 9s. 4d. has been earned during the ensuing six months (at the rate of nearly 5 per cent. on the issued capital of the company), and the continued expansion of the business indicates that this profit will be considerably increased by the end of the financial year, and that the anticipated benefit to this company by the acquisition of the control of the sales department will prove fully justified. The increase in the British and foreign sales are both equally satisfactory, and that the Bastian meter is a practical success is proved by the numerous repeat orders and testimonials constantly received by the company. The value of the goodwill has certainly increased, and the value of the patents has been well maintained by the addition of patents for important improvements in details of construction of the meter. The market in Spain has been opened up, and meters supplied to Madrid, Seville, Carthagena, Burgos, and many other towns; but the directors are of opinion that a large trade can only be safely conducted by manufacturing in the country, and negotiations for the sale of the Spanish patents are well advanced. Satisfactory orders are also being received from Belgium, and steps are being taken that the company's interests may be efficiently represented in South Africa. The Bastian meter, specially designed for use on electric tramcars, is just being put on the market, and the directors anticipate a large sale, as it supplies a distinct want. Mr. Thos. Johnston has been elected to a seat on the board, and, in accordance with the articles of association, his appointment is subject to confirmation by the shareholders. Mr. D. J. Cowles retires from the board by rotation, but, being eligible, offers himself for re-election. The auditors, Messrs. Percy Mason & Co., also offer themselves for re-election.

The British Westinghouse Electric and Manufacturing Co., Ltd.

MR. GEORGE WESTINGHOUSE presided last Friday at the third annual meeting of this company held at Westinghouse Building, Norfolk Street.

The secretary (Mr. RALEIGH B. PHILLPOTTS) having read the notice convening the meeting,

The CHAIRMAN said that he proposed to refer as briefly as possible to the progress which had been made since the last meeting, and to such matters as were of immediate importance. Manufacturing operations on a considerable scale are now being conducted at the works in Manchester, where all further orders for electrical machinery, steam turbines and gas engines will be executed. These orders include the eight 5,500-KW. turbines and generators for the Underground Electric Railways Co., of London, Ltd. (including the District Railway), and the three 3,500-KW. turbines and generators for the Metropolitan Railway Co., besides the entire steam and electrical apparatus for the Clyde Valley Power Co. There are now employed in the works at Manchester about 3,000 operatives, who, under experienced supervision, are rapidly becoming familiar with new methods of manufacture and the use of special machine and other tools. There was every reason to expect that the costs and rate of production would be entirely satisfactory. Many of the best workmen of the district are seeking employment in the works. It was the intention of the managers, while mindful of other interests, to fully meet the public expectation, that this enterprise would prove to be an object lesson to other British manufacturers; but "this can only be accomplished by the adoption of the machinery, practice and methods of those manufacturers who have surpassed and distanced other manufacturers who have continued to rely upon practices which many thoughful people now look upon as obsolete." During

the past year the business of the American companies, *i.e.*, the Westinghouse Electric and Manufacturing Co., and the Westinghouse Machine Co., both of Pittsburg, and Westinghouse, Church, Kerr & Co., of New York, had so increased as to make necessary the purchase of additional land and the erection of further workshops which will nearly double the present output capacity in order to meet existing demands. This increased capacity, it was hoped, would provide, in a small measure, for the requirements of some of the principal steam railways. The chairman continued: "Already railways are planning to extensively use electricity for the operation of suburban traffic, especially in and near New York, where the ever-increasing passenger traffic has developed new problems, which, apparently, can only be solved by the relegation of locomotives to the scrap-heap and the use of electric motors in their stead. The manufacturing and engineering operations involved in these new developments are so stupendous and of so novel a character that it has become very difficult for a single engineer, however able, to adequately meet the situation. Recognising this important fact, the Pennsylvania Railroad (one of the greatest business organisations in America), after the formation of a special board of officers and engineers to consider the subject in its several phases, has entrusted all that relates to the mechanical equipment of its power and passenger stations, and to the electrification of its tunnel system from New Jersey under the city of New York to Long Island, and for the Long Island Railroad, to Westinghouse, Church, Kerr & Co., as engineers and contractors. This company, which, as you know, is the engineering branch of the American Westinghouse Companies, has already executed some most important contracts, and in so doing has established a corps of engineers familiar with electric, steam and hydraulic engineering, and with the designing and construction of the buildings and other engineering works incident to the establishment of such great power plants."

The bearing on the British Westinghouse enterprise of this evidence of confidence was important, because the company was entitled to the benefit of the additional experience which would, as a result, be acquired by their American partners. This experience would be exemplified by drawings, plans and specifications, and the services of special engineers would be at all times available to their managers, and hence to the users of their apparatus. The developments of these several American companies in the matter of new designs of apparatus, new methods of operation and of manufacture, had been particularly important during the past year, and especially in respect of the construction and use of gas engines and Parsons steam turbine engines. The right to the manufacture and use of the latter in the territory covered by this company's operations had recently been acquired. "In the present practice of generating power, more than one-half of the fuel used is wasted, as compared with possible results. This waste of fuel, and the amount and value thereof, are so appalling as to justify large expenditures of capital to effect the saving of a commodity of vital importance, the supply of which is being rapidly exhausted. Recently the attention of the whole world has been particularly drawn to the subject by reason of the prolonged strike of the miners in the anthracite coal districts in Pennsylvania, one effect of which has been to greatly enhance the price of all kinds of fuel. It is estimated that over 600,000,000 tons of coal are annually mined and consumed throughout the world. The field of activity and the incentive for those who manufacture the apparatus to effect a saving of half of this output of coal need not be enlarged upon. The Parsons steam turbine for the driving of electric generators is an ideal device, and so long as steam is depended upon its use for power purposes can be widely extended, and your company has therefore made the manufacture of this type of engine a special feature. It is the conviction of your chairman that the gas engine will also prove the most important instrument for the cheap production of power, particularly if a simple and effective device be found to remove tar and dust from ordinary soft coal producer gas. He believes that such a device will soon be available to your company, the application of which will make the gas engine branch of your business large and profitable."

Already there was a very large demand for gas engines to be operated with gas made from anthracite coal or coke, which is cleaned sufficiently by a very simple apparatus. As stated in the report it was proposed to submit a resolution to increase the preference share capital to a total of £2,000,000, *i.e.*, to authorise a further issue of 200,000 £5 preference shares to rank *pari passu* with those already issued, and if so authorised. The directors would forthwith offer 100,000 of such new shares to the present proprietors at £5 10s. per share. This additional working capital, which their extensive plans had contemplated from the first, was fortunately needed sooner than some of them expected. He said "fortunately," because they had already secured such a volume of business as to justify the profitable use of the additional working capital which would be required to carry the materials and accounts involved in the execution of existing contracts. In illustration of the capital requirements of such an enterprise as this he mentioned a few figures relating to the American companies, whose business it was proposed they would duplicate at their plant in Manchester, so far as the demand within the territory will justify. "Their combined capital amounts to about £8,000,000. Their output for the present fiscal year ending March 31st next will exceed £6,000,000. Their orders and contracts in hand are very large, and the monthly receipts of new orders for a long period have equalled the output of the factories of all those companies, notwithstanding a constant increase in the facilities of each concern. With prompt collections, the running accounts outstanding and the value of the material in process and required in stock, aggregate nearly £4,000,000; and it may be further observed that the percentage of profit on the large amount of capital referred to (notwithstanding the keenest competition) is larger than when the volume of business was smaller, due to the fact that the later investments of capital have been, and should always be, much more remunerative than the capital first expended in the creation of the works and their equipment; and I may further add that both the preference and ordinary shares of the Westinghouse Electric and Manufacturing Co. have for some months commanded a premium of over 100 per cent., the dividends on both being at the rate of 7 per cent. per annum. The directors of the American Westinghouse Co. had authorised him at his discretion to take all of the 100,000 shares proposed to be issued which might not be applied for by the proprietors at £5 10s. per share, which authority he would take pleasure in exercising, for such action would assure to this company a premium of £50,000 on the issue of the 100,000 new preference shares.

"During the past year and a half the electric trade in all countries, except the United States, has been much demoralised by the practice of large Continental manufacturers who, from stress of circumstances, have offered their wares at prices believed to be much below their cost; and in some instances it is said that these manufacturers, to justify the difference in price for like apparatus, when used at home and when exported, have explained that they have adopted such a course of filling foreign orders for the purpose of ensuring employment to their workmen. Your managers have had occasion to note the effects of this course on the part of several important Continental manufacturers of electrical apparatus." The contract for the electrification of the Mersey Railway has progressed favourably, and the plant would, with the exception of some delay by the manufacturer in the delivery of a portion of the cars, be ready for operation early in January, about the time named in the contract for the completion of the work. If the results were comparable with those due to the electrification of the Manhattan Elevated Railway in New York, the proprietors of the Mersey Railway Co. should have cause for congratulation.

In his remarks last year he said:—"If railways want to protect the properties they have built up, they have got to take the initiative and handle their suburban traffic by electricity, instead of sitting still and seeing competing companies started to cut into them." He had previously given public expression to a belief, founded upon a careful consideration of their requirements, that the great railways of England could more advantageously purchase their supply of electric current from central power houses than by establishing the required number of smaller generating stations along their lines for their own use only. It seemed quite clear to him that the rate of development of electric traction in Great Britain would depend largely upon the facility with which the required capital can be raised, the machinery constructed, and the plants established. In the case of general power plants advantageously located each to supply a number of users, the total apparatus, material and capital required for their construction would probably not exceed one-half the amount of that needed if each of the railway companies should proceed to establish the numerous small plants which would be required for the operation of their local train service in a very extended area. Several of the leading companies have taken action in the direction indicated; among them the North-Eastern Railway has already invited tenders for the equipment of about 45 miles of its lines in and about Newcastle. This company, instead of building its own plant for the manufacture of electricity, was proposing to take a supply from the Newcastle-on-Tyne Electric Supply Co., which might be considered a precedent of importance, for it would undoubtedly draw attention to and establish the fact that the great railways can avoid a large expenditure of fresh capital by securing a supply of electricity from companies already having the required Parliamentary powers, or from other corporations yet to be formed. If there were to-day a supply of current available along the lines of railways, there would undoubtedly be a rapid development of electric traction upon branch lines, which are now operated with little satisfaction to the public, and at great cost to the railway companies. Besides the North-Eastern Railway, the Lancashire and Yorkshire Co. has announced its intention to electrify its line between Liverpool and Southport, while the Great Eastern and London and Brighton Railway Companies have given notice of their intention to apply for Parliamentary powers. It is worthy of note that the American railway companies enjoy great advantages over the English companies in the matter of the electrification of their railways, for such work is almost wholly done under existing general laws, while the like simple right is not available to the English railways.

"From your report it will be seen that there has been a most satisfactory growth of business, as indicated by the orders taken during the past fiscal year aggregating £932,000, and those received since the beginning of this year amounting to over £825,000. Skill has been shown by your manager, Mr. W. H. Wells, in the negotiations which have led to the securing of this business, and in equal manner Mr. H. S. Loud, your works' manager, has effectively advanced manufacturing operations, while Mr. Jas. C. Stewart, who erected your works at Manchester, and who has since become one of the managers of your company, being especially charged with the execution of contracts, has pushed forward the work of the electrification of the Mersey railway in a manner which has met with favourable comment from the parties interested and the public. A board of officers has been formed, consisting of the gentlemen named, with whom two members of the Executive Committee, Mr. J. H. Lukach and Col. Montagu Cradock, C.B., meet for the purpose of discussing the important business matters of the company. It is intended that this board of officers shall be enlarged by adding to it the treasurer and the works auditor of the company."

The adoption of the report was carried unanimously.

The retiring directors and auditors having been re-elected, the meeting became special and approved of the increase of the capital by £1,000,000 in 6 per cent. £5 preferred shares, which will be allotted in consideration to the holdings of the present proprietors, though, Mr. Westinghouse said, it was hardly practicable to do so *pro rata*.

Automatic Telephone Company.

An extraordinary general meeting of this company was held last Saturday, at Cannon Street Hotel, Mr. Max Margowski (managing director) presiding. After lengthy discussion, the resolutions submitted for re-constructing the company were passed with five dissentients. Voluntary liquidation, with Mr. E. G. Festing, the secretary, as liquidator, was approved. The new company will have the same name as the old, and the share capital will also be the same, viz.:—£100,000, divided into 47,940 preference shares of 2s. 6d. each, of which 4,000 shall be credited with 2s. paid up thereon, and 752,060 ordinary shares of 2s. 6d. each, credited with 2s. each paid up thereon. The directors had, previous to the meeting, circularised the shareholders to the following effect:—

Since the last annual general meeting the company has made great and substantial progress, and there can be no doubt that you possess an invention of great merit and commercial use, that must be generally adopted in consequence of its extreme simplicity, cheapness of construction, and adaptability to the present telephone systems in general use throughout the world. By the several circulars sent you during the last few months, you have been advised of the progress made, and a short time since you had the opportunity of seeing the commercial portable exchange of your system. During the whole of this time it has been necessary to keep the patents of your invention alive, and lately, to properly protect your interests, it was found necessary to apply for further patents for improvements. It will be in your recollection that at the last balance-sheet the company was practically without money, and that there were at that date 29,970 unissued shares. To carry on the affairs of the company, your directors had to seek for further means, and the board arranged that these unissued shares should be dealt with for that purpose. Your directors succeeded in placing a portion of these shares at 6 per cent. non-cumulative preference shares, at par, with a call on the balance. Your company having passed what may be called the experimental stage, it has become absolutely essential, to properly carry on its business, that it should have a factory, and you were informed in the circular letter of October 20th last that most suitable and desirable premises had been secured for that purpose. To properly equip with plant and machinery the factory in an up-to-date manner, further working capital is, in your directors' opinion, after giving the matter very careful and exhaustive study, absolutely necessary.

From the remarks made by Mr. Margowski, it seems that a practical gentleman had been engaged, on the recommendation of Prof. S. P. Thompson, with a view to perfecting the system. The missing link was the call box to call up a subscriber, "but the point was of minor importance, and had nothing to do with the system as a system."

South Wales Electrical Power Distribution Co.—Mr. Robert Forrest has accepted the chairmanship of this company, rendered vacant by the death of Mr. Archibald Hood. Mr. W. W. Hood has joined the board, and Mr. E. B. Martin—one of the original directors—who resigned his seat at the beginning of the year through ill-health, has now rejoined his former colleagues. Sir William Thomas Lewis, besides being an original director of the company, is also acting as one of the trustees for debenture holders.

Stock Exchange Notices.—The Committee has appointed special settling days as under:—Monday, December 29th, British Electric Traction Co., Ltd.—Further issue of 32,066 ordinary shares of £10 each, fully paid, Nos. 200,001 to 232,066; Wednesday, January 7th, British Electric Traction Co., Ltd.—Further issue of 18,937 6 per cent. cumulative preference shares of £10 each, fully paid, Nos. 300,001 to 318,937; and has ordered both sets of securities to be officially noted.

British Electric Street Trams, Ltd.—"A considerable shareholder," writes to the *Financial Times*, asking his fellow shareholders to combine in securing a searching investigation into the company's affairs, and the past management of the directors. He adds "The sum of £70,000 was subscribed by the shareholders, and it does not seem as if in two years this sum could have been lost in legitimate business."

Electrical Copper Co. — An extraordinary general meeting of this company was held on Tuesday at Winchester House, at which three or four shareholders were present. The proceedings were conducted in private.

National Telephone Co.—The transfer books of 3½ per cent. and 4 per cent. debenture stocks will be closed from the 18th to the 31st inst. inclusive, for the preparation of the warrants for the interest due January 1st.

STOCKS AND SHARES.

Wednesday Evening.

Money conditions ruling rather more easily than they often do at this time of year, the general markets in the Stock Exchange are half inclined to awake out of their lethargy. Certainly, a break in American railways does not conduce to a return of public confidence, and the dulness of Consols is another restraining influence. But, on the other hand, a breath of fresh speculation is wafting Kaffirs considerably higher, and Home railway stocks are what may be called tentatively good upon the approach of dividend time. The investment departments, on the whole, are doing a quiet business, and, as noted last week, electric supply shares give plenty of work to those connected with them. Telegraph securities remain dull, the Eastern group being under the maleficent influence of the new cable, but a fair amount of business passes daily in National Telephone issues.

City and South London Railway stock has slipped back a point, despite optimistic estimates as to the coming dividend announcement. Some sanguine souls talk of 4 per cent., which would make 3 per cent. for the whole year, but if the company pays 3½, there should be considerable satisfaction. The board are not likely to divide their profits up to the hilt, and no surprise need be felt if even the 3½ per cent. prophets turn out to have been over sanguine. For the latter half of 1901 the City and South London paid 2¼ per cent. on its Ordinary stock. A noticeable feature in regard to this company is the demand which is in evidence for the Third Preference, now quoted about 126. Sellers might probably get this price, for there is very little stock on offer, and the buyers appear eager to have it. Considering that it pays all but 4 per cent. on the money, and is apparently excellently secured, holders are not likely to sell at the present comparatively low price, better though it be than that which has prevailed for the last few months. Central London stocks have not moved. The dividend seers are putting 4 per cent. as the probable distribution on the Ordinary, and the same on the Deferred. Great Northern and City Preferred are 8, and East London hangs helplessly at 6. Metropolitan Consolidated is being put along in a steady fashion, and has got up to 85½, after touching 86, which is the highest figure reached this year.

A much firmer tone characterises the British Electric Traction issues, all these having advanced during the week. Sales of the new Preference shares have stopped for the time being, and a little support came to the aid of the market at an opportune moment. British Westinghouse application papers for the new Preference shares are now out; some disappointment exists over the way in which the issue is being made. The new shares are not offered *pro rata*, so a good many proprietors are likely to think the matter too much trouble to consider. The applications have to go in by next Monday at latest, only six days after the circular offering the shares was in the shareholders' hands. The Christmas week is by no means the time when present-buying people care to make application for shares upon which 10s. each is payable forthwith, and £1 on allotment, and so on. There is not much of a bonus in the price of the shares, which are offered at £5 10s. and rank for dividend after January 31st, 1903, so that, after allowing for this interest and the unmarketability attaching to new shares, the profit does not amount to anything substantial. Nevertheless, the shares are certainly cheap, and British proprietors will be foolish to lose their chance of allotments, for all the shares not taken up by them will go to others who have already made an offer for them. There is a ½ premium on them now.

In the telegraph market, Eastern Ordinary has eased off a point, and "China" shares are again down. The fall in these last has been much more severe than that in Eastern stock, and Eastern Extensions, regarded as stock, are now some 10 per cent. lower than Eastern Ordinary. But the 4 per cent. Debenture stock of the Eastern Co. has risen a trifle. Western Telegraph shares are down ¼; the dividend deducted practically accounts for the decline. So far, the trouble in regard to Venezuela has not affected any of the stocks in this department. The American group is unaltered on the week. Marconi shares enjoyed a sharp sprint the other day, advancing from 2 15/16 to 3 1/16. The buying was of the usual professional order.

In the electric supply department, a fall in City of London goes against an improvement in Charing Cross and Strand shares. The latter may, perhaps, be due to the enterprising fashion in which the Charing Cross Co. is pushing its City business, and possibly the decline in "City Lights" is not unconnected with the same reason. Edmundson Ordinary are being largely bought, and the price shows a rise of ¼, while County of London and Brush Preference are 10s. to the good. Blackheath Ordinary slid back 2s. 6d. on the appearance of a small seller. One or two of the gilt-edged stocks in this department were marked *ex* dividend on the last Stock Exchange account day, but the deductions are being recovered. City of London Second Debenture is again harder, despite the fall in the price of the shares. Brush Second Debenture has lost the point it picked up a week ago, and beyond this the miscellaneous group shows no alteration in values.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1899.	1900.	1901.	Closing Quotations Dec. 16th.	Closing Quotations Dec. 17th.	Business done week ended Dec. 17th, 1902. Highest	Lowest.
67,100	African Direct Telegraph, 4 % Debs.	100	..	..	..	98 —102	98 —102	..	..
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	..	..	..	2¼ — 3⅛	2¼ — 3⅛	..	..
119,700£	Do. do. 5 % Debs., Nos. 1 to 1,250 Red.	100	..	..	..	70 — 80	70 — 80	..	..
798,840	Anglo-American Telegraph	Stock	7¾6	3½%	61s.	49 — 52	49 — 52	49	..
3,105,580	Do. do. do. 6 % Pref.	Stock	6 %	6 %	6 %	93 — 95	93 — 95	94½	93½
3,105,580	Do. do. do. Deferred	Stock	£1 7s.	5s. %	2s.	8⅜ — 9	8⅜ — 9	9	8⅛
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	5 %	5 %	4 — 4½	4 — 4½	..	..
13,333,300$	Commercial Cable	$100	8 %	8 %	8 %	178 —188	178 —188	..	..
1,841,309	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	..	..	..	94 — 96	94 — 96	95½	94½
16,000	Cuba Telegraph	10	7 %	4½%	4 %	5 — 6	5 — 6	..	..
6,000	Do. 10 % Pref.	10	..	..	..	12⅛ — 13⅛	12⅛ — 13⅛	..	..
12,981	Direct Spanish Telegraph	5	4 %	4 %	4 %	2⅝ — 3⅛	2⅝ — 3⅛	..	..
6,000	Do. do. 10 % Cum. Pref.	5	..	..	..	7 — 8	7 — 8	..	..
60,710£	Direct United States Cable	20	3½%	3½%	3½%	10⅛ — 10⅜	10⅛ — 10⅜	10⅛	10⅛
96,300	Direct West India Cable, 4½% Reg. Deb., within Nos. 1 to 1,200, Red.	100	..	..	..	100 —103	100 —103	..	..
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	7 %	123 —128	122 —127	125	123
1,955,555	Do. 3½ % Pref. Stock	100	..	..	..	89 — 92	89 — 92	..	..
1,594,645	Do. 4 % Mort. Deb. Stock Red.	Stock	..	..	..	104 —107	105 —108	105½	..
300,000	Eastern Extension, Australasia, and China Telegraph	10	7 %	7 %	7 %	11⅛ — 11⅜	11⅜ — 12⅛	11⅜	11⅛
320,000£	Do. 4 % Deb. Stock	Stock	..	..	..	107 —110	107 —110	..	..
300,000	Eastern & South African Tele., 4% Mt. Db., Nos. 1 to 3,000, red. 1909	100	5⅛%	..	..	99 —102	99 —102	..	..
200,000£	Do. do. 4 % Reg. Mort. Debs. (Mauritius Sub.) 1 to 8,000	25	..	..	..	99 —102 %	99 —102	..	..
180,227	Globe Telegraph and Trust	10	5⅛%	5⅛%	5⅛%	9 — 9⅛	9 — 9⅛	9 7/16	9
180,042	Do. do. 6 % Pref.	10	..	..	..	13 — 13⅜	13 — 13⅜	..	..
150,000	Great Northern Telegraph, of Copenhagen	10	12½%	15 %	15 %	26 — 27	26 — 27	..	..
70,000	Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	..	..	..	100 —103	100 —103	..	..
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	39 — 43	39 — 43	41	40
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	..	..	..	101 —105	101 —105	..	..
72,680	Montevideo Telephone, Ltd., Ord. Nos. 1 to 72,680	1	2½%	..	..	⅛ — ¼	⅛ — ¼	..	..
86,492	Do. do. 5 % Pref., Nos. 1 to 86,492	1	5 %	..	..	¾ — 1	¾ — 1	..	..
1,988,333	National Telephone, Pref. Stock	100	5 %	5 %	5 %	92 — 94	92 — 94	93¼	92
1,966,667	Do. do. Def. Stock	100	..	60	64 xd	62 — 64	63 — 65	64½	62¼
15,000	Do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	12½ — 13½	12½ — 13½	..	..
15,000	Do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	11½ — 12½	11½ — 12½	..	..
250,000	Do. do. 5 % Non-cum. 3rd. Pref., 1 to 250,000	5	5 %	5 %	5 %	5 — 5¼	5 — 5¼	5 5/16	..
2,000,000£	Do. do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	95 — 98	95 — 98	96½	..
600,000	Do. do. 4 % Deb. Stock Red.	100	..	4 %	4 %	101 —105	101 —105	103½	103
171,504	Oriental Telephone and Elec. Nos. 1 to 171,504, fully paid	1	5 %	6 %	6 %	7/8 — 1	7/8 — 1	..	..
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000	100	..	..	..	99 —102	99 —102	..	..
11,839	Reuter's	8	5 %	5 %	5 %	6½ — 7½	6½ — 7½	..	..
3,303	Submarine Cables Trust	Cert.	..	..	..	110 —120	110 —120	..	..
58,000	United River Plate Telephone	5	7 %	7 %	7 %	5 — 5⅛	5 — 5⅛	..	..
40,000	Do. do. 5 % Cum. Pref., Nos. 1 to 40,000	5	..	..	..	4⅞ — 5	4⅞ — 5	..	..
179,947£	Do. do. 5 % Debs.	Stock	..	..	..	102 —105	102 —105	..	..
15,669	West African Telegraph, Shares	10	..	..	..	3 — 4	3 — 4	..	..
30,008	West Coast of America, Nos. 1 to 30,000 and 53,001 to 53,008	2½	..	..	..	0 — ¼	0 — ¼	..	..
150,000£	Do. do. 4% Debs., 1 to 1,500 guar. by Braz. Sub. Tel.	100	..	..	..	98 —101	98 —101	..	..
267,930	Western Telegraph, Ltd., Nos. 1 to 207,930	10	7 %	7 %	7 %	11¼ — 12	11¼ — 11⅝ xd.	11⅝	11⅝
75,000£	Do. do. 5 % Debs. 2nd series, 1906	100	..	..	..	102 —105	102 —105	..	..
400,000	Do. do. 4 % Deb. Stock Red.	100	..	..	..	99 —102	99 —102	..	..
88,321	West India and Panama Telegraph	10	5%	5%	..	5/8 — 7/8	5/8 — 7/8	..	..
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	..	..	..	4½ — 5¼	4½ — 5¼	5 3/16	..
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	..	..	..	3 — 4	3 — 4	..	..
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	..	..	..	100 —103	100 103	..	..

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

20,000	British Aluminium 7 % Cum. Pref.	10	..	5¼%	..	3 — 4	3 — 4	..	..
300,000£	Do. do. 5% 1st Mort. Deb. Stock Red.	Stock	..	..	..	75 — 80	75 — 80	..	..
100,000	British Electric Traction	10	8 %	9 %	9 %	12½ — 12⅞	12⅞ — 13⅛	13	12⅝
100,000	Do. do. 6 % Cum. Pref.	10	..	..	..	11⅞ — 12⅛	12 — 12⅛	12⅛	..
600,000£	Do. do. 5 % Perpetual Debenture Stock	Stock	..	..	..	123 —126	124 —127	125½	125½
100,000	British Insulated Wire Ord.	5	20 %	15 %	10 %	7⅞ — 8	7⅞ — 8	..	..
100,000	Do. do. 6 % Cum. Pref.	5	..	..	..	5⅞ — 6	5⅞ — 6	..	..
50,000	Do. do. 4½ % 1st Mort. Deb. Red.	100	..	..	..	103 —106	103 —106	..	..
50,000	¶Browett, Lindley & Co. (1899), Ord.	£1	..	8 %	..	12/6 to 13/6	12/6 to 13/6	..	..
50,000	¶ Do. do. 6 % Cum. Pref.	£1	..	6 %	..	15/6 to 17s.	15/6 to 17s.	..	..
105,731	Brush Electrical Engineering, Ord., 1 to 105,731	2	5⅛%	5 %	Nil	¾ — 1⅛	¾ — 1⅛	..	..
150,000	Do. do. Non-cum. 6 % Pref.	2	6 %	6 %	3 %	1 — 1⅛	1 — 1⅛	1 1/16	..
125,000£	Do. do. 4½ % Perp. Deb. Stock	Stock	..	..	..	100 —103	100 —103	..	..
125,000£	Do. do. 4½ % Perp. 2nd Deb. Stock	Stock	..	..	..	94 — 99	93 — 98	..	..
35,000	Callender's Cable Construction shares	5	15 %	15 %	20 %	14 — 15	14 — 15	14½	..
40,000	Do. do. do. 5 % Cum. Pref.	5	..	..	..	5½ — 6	5½ — 6	..	..
90,000£	Do. do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	..	..	..	109 —113	109 —113	..	..
1,860,014	Central London Railway, Ord. Stock	Stock	..	..	4 %	106 —109	106 —109	108	107⅝
494,093	Do. do. 4 % Pref. Stock	Stock	..	..	4 %	105 —108	105 —108	..	..
494,993	Do. do. Def. do.	Stock	..	..	4 %	106 —109	106 —109	..	..
1,330,000	City and South London Railway	Stock	1⅞%	1½%	2 %	76 — 77	75 — 76	76½	75
85,000	Crompton & Co., Nos. 1 to 85,000	3	7½%	8 %	7½%	2½ — 3	2½ — 3	..	..
100,000£	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 red.	..	..	..	..	101 —106 %	101 —106 %	..	..
99,261	Edison & Swan United Elec. Light, "A" shares, £3 paid, 1 to 99,261	5	6 %	2½%	..	⅛ — ¼	⅛ — ¼	..	..
17,139	Do. do. "A" shares, 01—017,139	5	6 %	2½%	..	1½ — 2¼	1½ — 2¼	..	..
344,028£	Do. do. 4 % Deb. Stock Red.	100	..	..	..	74 — 78	74 — 78	..	..
100,000£	Do. do. 5 % 2nd Deb. Stock Prov. Certs. all pd.	100	..	..	..	77 — 82	77 — 82	..	..
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	6 %	1¾ — 1⅞	1¾ — 1⅞	..	..
31,390	Do. do. 7 % Cum. Pref., 1 to 31,390	2	..	..	..	2¼ — 2⅜	2¼ — 2⅜	..	..
182,500£	Do. do. 4 % Perp. 1st Mort. Deb. Stock	Stock	..	..	..	99 —102	99 —102	..	..
25,000	General Electric Co. (1900), 5 % Cum. Pref.	10	..	5 %	5 %	10 — 10½	10 — 10½	..	..
200,000	Do. do. 4 % Mort. Deb.	Stock	..	..	..	99 —102	99 —102	..	..
35,000	Henley's (W. T.) Telegraph Works, Ord.	5	15 %	20 %	20 %	16½ — 17⅜	16½ — 17⅜	..	..
35,000	Do. do. 4½ % Pref.	5	4½%	4½%	..	5¼ — 5⅜	5¼ — 5⅜	5⅜	..
48,050	Do. do. 4½ Mort. Deb. Stock	Stock	..	..	..	100 —113	100 —113	..	..
50,000	India-Rubber, Gutta-Percha & Telegraph Works	10	10 %	10 %	10 %	20½ — 21½	20½ — 21½	21¼	21¼
300,000£	Do. do. do. 4 % 1st Mort. Deb.	100	..	..	..	100 —103	100 —103	..	..
37,500	†Liverpool Overhead Railway, Ord.	10	3½%	3½%	1¼%	6¼ — 6¾	6¼ — 6¾	..	..
10,000	† Do. do. Pref. £10 paid	10	5 %	..	..	9½ — 10¼	9½ — 10¼	..	..
7,500	Parker (Thomas), Ltd., Ord., Nos. 1 to 7,500	10	..	..	..	14½ — 15½	14½ — 15½	..	..
	§Rosling & Fynn 6 % Cum. Pref.	£1	..	6 %	..	19/0 to 20/0	..	..	..
87,350	Telegraph Construction and Maintenance	12	15 %	17½%	20 %	37 — 40	37 — 40	39	38
150,000£	Do. do. 4 % Deb. Bds., Nos. 1 to 1,500 Red. 1909	100	..	..	..	102 —105	102 —105	104	..
540,000£	Waterloo & City Railway, Ord. Stock	100	3 %	3 %	3 %	93 — 96	93 — 96	..	..

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.
§ From Bradford Share List. ¶ From Manchester Share List.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Consolidated Telephone Construction and Maintenance, ⅛—⅜.
National Electric Free Wiring, ½—1.
Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 13—14.
Do. do. Pref. (£10 pd.), 10—11.

Bank rate of discount 4 per cent. (October 2nd, 1902).

SHARE LIST OF ELECTRICAL COMPANIES (*continued*).—ELECTRICITY SUPPLY COMPANIES.

Present issue.	NAME.	Stock or Share.	Dividends for the last three years. 1899.	1900.	1901.	Closing Quotations Dec. 10th.	Closing Quotations Dec. 17th.	Business done week ended Dec. 17th, 1902. Highest.	Lowest.
100,000	Blackheath and Greenwich Dist. Electric Light, Ord.	‡				⅜ — ¾	⅜ — ¾	..	..
100,000	Do. 4½% 1st Deb. Stock, Prov. Certs.	1	..	..	..	..	..	..	..
20,000	Brompton & Kensington Electric Light Sup., Ord., 1 to 20,000	100	..	..	..	110 —113	110 —113	..	..
20,000	Do. do. 7% Cum. Pref.	5	6 %	6 %	8 %	10 — 10¼	9⅞ — 10⅛	..	..
50,000	Charing Cross and Strand Electricity Supply	5	..	..	..	9 — 10⅛	9⅞ — 10⅛	..	..
70,000	Do. do. do. 4½% Cum. Pref.	5	9 %	9 %	10 %	9 — 9⅝	9⅛ — 9⅝	9⅝	9⅛
40,000	Do. do. "City Undertaking" 4½% Cum. Pref.	5	..	..	..	5⅛ — 5⅜	5⅛ — 5⅜	..	..
250,000	Do. do. 4 % Deb. Stock Red.	5	..	..	..	4⅞ — 5⅛	4⅞ — 5⅛	..	..
44,495	*Chelsea Electricity Supply, Ord.	100	..	..	..	105 —107	103 —105 xd	104½	..
150,000‡	Do. do. % Deb. Stock Red.	5	6 %	5½%	4 %	5⅝ — 6	5⅛ — 6	5⅝	..
70,595	City of London Electric Lighting, Ord. 40,001—110,595	Stock	..	..	..	110 —113	110 —113	..	..
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	4 %	0 %	5 %	10 — 11	9½ — 10⅝	10⅛	10⅛
400,000‡	Do. 5 % Deb. Stock, Scrip. (iss. at 115) all paid	10	6 %	6 %	..	13 — 14	13 — 14	..	..
300,000	Do. 4½% 2nd Deb. Stock, Prov. Certs., all paid	..	..	..	..	124 —129	124 —129	..	..
40,000	County of London & Brush Prov. Electric Lighting, Ord. 1—40,000	100	..	..	..	103 —106	104 —107	..	..
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	4 %	4 %	4 %	8½ — 9½	8½ — 9½	..	..
400,000‡	Do. do. 4½% Deb. Stock, Prov. Certs. (all paid) Red	10	6 %	6 %	..	11½ — 12½	12 — 13	..	..
50,000	Edmundson's Electric Corporation, Ord. Shares	..	..	..	..	109 —112	109 —112	11	..
30,000	Do. do. 6 % Cum. Pref.	5	6 %	7 %	7 %	6 — 6⅝	6 — 6⅝	6⅝	6⅜
140,000	Do. do. 4½% 1st Mort. Deb. Stock	..	..	..	..	6 — 6⅝	6 — 6⅝	6⅝	6⅜
21,000	Kensington and Knightsbridge Electric, Ord.	100	..	..	..	107 —110	107 —110	108½	..
90,000	Do. do. do. 4 % Debenture Stock	5	11 %	12 %	10 %	10 — 11	10 — 11	10¼	..
110,000	ondon Electric Supply Corporation, Limited, Ord.	Stock	..	..	..	101 —104	101 —104	..	..
49,840	Do. do. do. 6 % Pref.	3	..	..	..	1⅞ — 2⅛	1⅞ — 2⅛	..	..
250,000‡	Do. do. do. 4 % 1st Mort. Deb. Stock Red	5	..	..	..	5 — 5⅛	5 — 5⅛	5⅛	..
100,000	Metropolitan Electric Supply, 1 to 100,000	Stock	..	..	..	96 — 99	95 — 98 xd	..	..
220,000‡	Do. do. 4½% 1st Mort. Deb. Stock	10	5 %	6 %	6½%	15½ — 16½	15½ — 16½	16	15⅝
250,000‡	Do. do. 3½% Mort. Deb. Stock Red	..	..	..	..	109 —114	109 —114	..	..
10,852	Notting Hill Electric Lighting	Stock	..	..	..	99 —102	99 —102	..	..
40,000	St. James' and Pall Mall Electric Light, Ord.	10	7 %	7 %	6 %	14½ — 15½	14½ — 15½	..	..
20,000	Do. do. do. 7 % Pref. 20,081 to 40,080	5	14½%	14½%	14½%	14⅝ — 15⅜	14⅝ — 15⅜	14⅞	14⅜
150,000‡	Do. do. do. 3½% Deb. Stock Red	5	7 %	7 %	7 %	8⅝ — 9⅛	8⅝ — 9⅛	9⅛	..
12,000	Smithfield Markets Electric Supply, Ord.	100	..	..	..	98 —101	98 —101	..	..
50,000‡	Do. do. 4% Deb.	5	..	..	..	1⅞ — 2⅛	1⅞ — 2⅛	..	..
65,000	South London Electricity Supply, Ord.	100	..	..	..	80 — 90	80 — 90	..	..
30,000	Urban Electric Supply, Ord., £4 pd.	5	..	..	..	3 — 3⅛	3 — 3⅛	..	..
30,000	Do. do. 5 % Cum. Pref., £4 pd.	5	..	..	..	3⅝ — 4⅛	3⅝ — 4⅛	..	..
110,000	Westminster Electric Supply, Ord.	5	13 %	10½%	10½%	3⅝ — 4⅛	3⅝ — 4⅛	..	..
92,141	Do. do. 5 % Cum. Pref.	5	..	..	..	11 — 12	11 — 12	11 7/16	..
		5	..	..	..	6 — 6⅛	6 — 6⅛	6 1/16	6⅛

*Subject to Founders Shares. ‡Unless otherwise stated all shares are fully paid.

MARKET QUOTATIONS, Wednesday, December 17th.

	CHEMICALS, &c.		Last week.	This week.	Inc. or Dec.
a	Acid, Hydrochloric	per cwt.	5/-	5/-	..
a	,, Nitric	per cwt.	22/-	22/-	..
a	,, Oxalic	per cwt.	32/-	32/-	..
a	,, Sulphuric	per cwt.	5/6	5/6	..
a	Ammoniac, Sal	per cwt.	42/-	42/-	..
a	Ammonia, Muriate (crystal)	per ton	£33 10	£33 10	..
a	,, ,,	per ton	£30	£30	..
a	Bleaching powder	per ton	£4 10	£4 10	..
a	Bisulphide of Carbon	per ton	£15	£15	..
a	Borax	per ton	£13	£13	..
a	Benzole (90 %)	per gal.	7/-	7/-	..
a	,, (50/90 %)	per gal.	5/6	5/6	..
a	Copper Sulphate	per ton	£17 10	£17 10	..
a	Lead, Nitrate	per ton	£24	£24	..
a	,, White Sugar	per ton	£31	£31	..
a	,, Peroxide	per ton	£27 10	£27 10	..
a	Methyiated Spirit	per gal.	2/6	2/6	..
a	Naphtha, Solvent (90% at 160° C).	per gal.	5/6	5/6	..
a	Potash, Bichromate, in casks	per lb.	3d.	3d.	..
a	,, Caustic (75/80%)	per ton	£24	£24	..
a	,, Bisulphate	per ton	£25	£25	..
a	Shellac	per cwt.	130/-	130/-	..
a	Sulphate of Magnesia	per ton	£4 10	£4 10	..
a	Sulphur, Sublimed Flowers	per ton	£6 5	£6 5	..
a	,, Recovered	per ton	£5 10	£5 10	..
a	,, Lump	per ton	£5	£5	..
a	Soda. Caustic (white 70 %)	per ton	£10 15	£10 15	..
a	,, Crystals	per ton	£3	£3	..
a	,, Bichromate, casks	per lb.	2¼d.	2¼d.	..
	METALS, &c.				
b	Aluminium Ingots, in ton lots	per ton	£148	£148	..
b	,, Wire, in ton lots	per ton	£224	£224	..
b	,, Sheet, in ton lots	per ton	£191	£191	..
p	Babbit's metal ingots	per ton	£40 to £130	£40 to £130	..
c	Brass (rolled metal 2" to 12") basis	per lb.	6½d.	6½d.	..
c	,, Tube (brazed)	per lb.	8½d.	8½d.	..
c	,, ,, (solid drawn)	per lb.	6½d.	6½d.	..
c	,, Wire, basis	per lb.	6¼d.	6¼d.	..
c	Copper Tubes (brazed)	per lb.	8½d.	8½d.	..
c	,, ,, (solid drawn)	per lb.	9d.	9d.	..
g	Copper Bars (best selected	per ton	£65	£67	£2 dec.

	METALS, &c. (*continued*).		Last week.	This week.	Inc. or Dec.
g	Copper Sheet	per ton	£65	£67	£2 dec.
g	,, Rod	per ton	£65	£67	£2 dec.
e	,, (Electrolytic) Bars	per ton	£55	£55	..
e	,, ,, Sheets	per ton	£73	£73	..
e	,, ,, Rod	per ton	£61	£61	..
e	,, ,, H.C. Wire	per lb.	7d.	7d.	..
f	Ebonite Rod	per lb.	3/-	3/-	..
f	,, Sheet	per lb.	5/-	5/-	..
n	German Silver Wire	per lb.	1/4½	1/4½	..
h	Gutta-percha fine	per lb.	8/-	8/-	..
h	India-rubber, Para fine	per lb.	3/4½ to 3/7½	3/2 to 3/5	2½d. inc.
i	Iron, Charcoal Sheets	per ton	£18	£18	..
i	,, Pig (Cleveland warrants)	per ton	47/6	48/6	1/- dec.
i	,, Forgings, according to size	per ton	From £11	From £11	..
i	,, Scrap, heavy	per ton	47/6 to 50/-	47/6 to 50/-	..
i	,, Wire, galvanised No. 8	per ton	£9 15	£9 15	..
g	Lead, English Ingot	per ton	£11 to £11 2 6	£10 13 9 to £10 15	inc.
g	,, ,, Sheet	per ton	£18	£18	..
m	Manganin Wire No. 28	per lb.	8/-	8/-	..
g	Mercury	per bot.	£8 15	£8 15	..
d	Mica (in original cases) small	per lb.	3d. to 9d.	3d. to 9d.	..
d	,, ,, ,, medium	per lb.	1/9 to 2/9	1/9 to 2/9	..
d	,, ,, ,, large	per lb.	3/3 to 7/3	3/3 to 7/3	..
p	Phosphor Bronze, plain castings	per lb.	11½d. to 1/2	11½d. to 1/2	..
p	,, rolled bars & rods	per lb.	1/- to 1/3	1/- to 1/3	..
p	,, ,, strip & sheet	per lb.	From 1/2	From 1/2	..
o	Platinum	per oz.	£4	£4	..
p	Silicium Bronze Wire	per lb.	9d. to 1/-	9d. to 1/-	..
i	Stee., Magnet, acc'd'g to desc'p'n	per ton	£58	£58	..
i	,, ,, in bars	..	From £1 5	From £40 to £40	..
g	Tin, Block	per ton	£118 to £119	£113 to £114	£5 inc.
g	,, Foil	per lb.	1/6	1/6	..
n	,, Wire, Nos. 1 to 16	per lb.	1/6½	1/6½	..
p	White Anti-friction Metals— "White Ant" brand	per ton	£36 to £60	£36 to £60	..
j	Yarns, 2/10s Grey Cotton, on sp'ls	per lb.	7d.	7d.	..
j	,, 6 lea. Flax	per lb.	5⅞d.	5⅞d.	..
j	,, 3 ply 10 lbs. Russian	per lb.	4½⅞d.	4½⅞d.	..
j	,, 10 lbs. Russian, single	per lb.	4¼d.	4¼d.	..
j	,, 180 lbs. Jute rove	per ton	£11 11	£11 11	..
k	Zinc, Sh't (Vieille Montagne bnd.)	per ton	£23	£23	..

Quotations supplied by: a Messrs. G. Boor & Co. b The British Aluminium Co., Ltd. c Messrs. Thos. Bolton & Sons., Ltd. d Messrs. F. Wiggins & Sons. e Messrs. Frederick Smith & Co.

Quotations supplied by: f India-Rubber, G.P. and Teleg. Works g Messrs. James & Shakspeare. [Co., Ltd. h Messrs. Edward Till & Co. i Messrs. Bolling & Lowe. j Messrs. Walter H. Hindley & Co., Ltd.

Quotations supplied by: k Messrs. Morris Ashby, Limited. m Messrs. W. T. Glover & Co., Ltd. n Messrs. P. Ormiston & Sons. o Messrs. Johnson, Matthey & Co., Ltd. p The Phosphor Bronze Company Ltd.

TRAFFIC RECEIPTS.

Company.	Week ending	Receipts for the week. Am'nt.	Inc. or dec.*	Total to date. Am'nt.	Inc. or dec.*	Miles open. This year	Last year.
		£	£	£	£		
Blackburn Corp. Trys.	Dec. 12	598	— 18	30,743	+ 3,920	12¾	13¾
Blackpool and Fleetwood	,, 13	142	+ 7	20,483	— 166	7¾	7¾
Bristol Trys. & Car. Co.	,, 12	3,871	+155	—	—	28	28
British Elec. Trac. Co.:—							
Barnsley	,, 5	134	—	655	—	—	—
Devonport	,, 5	869	— 14	10,807	+ 1,203	5	5
Dudley—Stourbridge	,, 5	699	+ 66	36,675	+ 4,582	18¾	18¾
Gateshead	,, 5	819	+204	37,186	+ 7,459	10¾	9¾
Gravesend—Northfleet	,, 5	159	—	3,685	—	3¼	—
Greenock—Pt. Glasgow	,, 5	424	+ 64	24,294	+13,346	7¾	7¾
Hartlepool	,, 5	204	+ 24	12,249	+ 1,211	6¾	4¾
Kidderminster	,, 5	91	+ 0	5,996	+ 66	4½	4½
Merthyr	,, 5	163	— 17	9,640	— 1,741	3	3
Middleton	,, 5	208	—	10,602	—	5½	—
Oldham—Ashton	,, 5	482	+ 43	25,901	+ 1,557	8	8
Poole	,, 5	191	+ 11	12,589	+ 6	3¾	3¾
Potteries	,, 5	1,581	+202	78,314	+ 4,831	28¾	28¾
Rothesay	,, 5	38	+ 13	1,887	+ 614	—	—

Company.	Week ending	Receipts for the week. Am'nt.	Inc. or dec.*	Total to date. Am'nt.	Inc. or dec.*	Miles open. This year.	Last year.
		£	£	£	£		
B.E.T. Co. (*continued*)— Southport	Dec. 5	216	+106	12,526	+ 4,582	5¾	5¾
South Staffordshire	,, 5	587	—190	36,483	— 1,404	21¾	23¾
Swansea	,, 5	419	+ 23	23,004	+ 1,518	5¾	5¾
Taunton	,, 5	46	+ 3	3,125	— 343	1¾	—
Tynemouth	,, 5	192	+ 27	14,281	+ 2,016	3¾	3¾
Weston-super-Mare	,, 3	27	—	5,517	—	2¾	—
Wolverhampton Dist.	,, 5	299	+194	10,751	+ 6,998	10¾	3¾
Central London Railway	,, 13	7,329	+471	160,389	+19,925	6	6
City and S. London Ry.	,, 14	3,877	+417	74,455	+22,126	6¾	6¾
Doncaster Corp. Trys.	—	—	—	—	—	5¾	—
Dover Corporation Trys.	,, 13	149	— 19	10,813	+ 17	3	3
Dublin United Trys.	,, 12	3,912	— 64	113,936	+ 2,857	45	45
East Ham Tramways	,, 13	411	+126	12,508	+ 2,609	5	5
Glasgow Corp. Trys.	,, 13	11,516	+1,326	342,861	— 5,626	62	62
Liverpool Overhead Ry.	,, 14	1,369	+ 33	37,157	— 582	6¾	6¾
Newcastle Corp. Trys.	,, 13	2,919	—	—	—	25	—
Sunderland Corp. Trys.	,, 14	962	— 37	—	—	17¾	17¾

* Compared with the corresponding period of 1901.

INSTITUTION OF ELECTRICAL ENGINEERS.

SOME LIMITS IN HEAVY ELECTRICAL ENGINEERING.

Abstract of inaugural Address by the President, James Swinburne, delivered December 4th, 1902.

(*Continued from page* 1001.)

The turbine is under the same limit as regards pressure, in fact, high pressures are perhaps even more difficult to use, and superheating does not, as already explained, seriously increase the mutivity of the heat taken in by the boiler. The turbine is almost perfect thermodynamically. There is practically no variation of temperature of any part of it, so there is no growth of entropy by conduction. Wire-drawing produces kinetic energy which is wholly convertible into work. There must be increase of entropy, however, through eddies and steam friction. In fact, one aim in design is to avoid the turbine being a large "porous plug." There is no admission condensation, and the increase of entropy of the steam passing through should prevent any expansion condensation. If superheating is necessary to prevent expansion condensation, it is the highest compliment to the designer, for it shows the wire drawing due to irreversible expansion and that due to the leakage and the axial conduction of heat taken together are not enough to prevent expansion condensation, and the accompanying friction and entropy production near the exhaust end. Comparatively little superheating decreases not only the water, but the heat consumption of a Parsons turbine.

One of the chief disadvantages of steam engines for stations with small load-factors, is the difficulty of storing energy so as to get uniform boiler load. What is wanted is a reservoir containing something which undergoes a physical or chemical isothermal change; for instance, a substance that fuses at the right temperature, and has a high latent heat of fusion. Unfortunately, there is no substance within the range of practical engineering. Moreover, the storage is on the wrong side of the engine. The difficulty of storage is another drawback to the steam engine, and gives the gas engine a further advantage.

Before leaving the steam engine, it may be in place if I bring before the Institution a recommendation of the Institution of Civil Engineers, that, in future, the British Thermal Unit be written B.Th.U. instead of B.T.U., as B.T.U. is used for "Board of Trade Unit."

The Gas Engine.—The simplest ideal form is a machine that pumps a small volume of air under a high pressure into a furnace, and draws out a large volume of gases at the same pressure and a very high temperature. The engine should then expand this gas down to the temperature of the air. The limits of the gas engine are essentially constructive, and the difficulties in the way of large gas engines are enormous. Theoretically the gas engine has a very great advantage. The possible range of temperature is so high that the mutivity approaches unity. In addition to this the combustion, whether inside the engine or not, is very efficient. But a reciprocating engine cannot work at the temperature of burning carbon, or hydro-carbons. If the gases are exploded there is great strain on all the working parts. Next there is difficulty about the expansion. It would be good to make the engine compound, but then the valves give trouble. Opening a mushroom valve against the gas in a large engine means a matter of tons. There would clearly be difficulty in leading hot gases about through complicated valve passages to intermediate and low-pressure cylinders. All the same the compound gas engine must come in. At present we waste a great deal of energy in the exhaust, and we have to make the cylinder large enough for the expansion, and strong enough for the explosion. Though we begin with gas at going on for 2,000° A., with a mutivity at a lower temperature of the air 0·86, we have to exhaust at such a high temperature that the mutivity is, say, 0·4, or a little better than in the steam engine. If a certain range of temperature is available, it is better to have it at a low temperature, so that the mutivity is greater. We have thus in the gas engine a machine which from a thermo-dynamical point of view ought to be exceedingly good; but the difficulties in building reduce the efficiency enormously. In spite of that, the large gas engine seems likely to oust the steam engine for large powers during the next few years. The best way to get a high efficiency out of a gas engine would probably be to make it compound, exhausting at a temperature suitable for raising steam. The steam engine would then exhaust at a temperature suitable for raising SO_2 vapour. But the chances are that Dowson, Mond, or other producer gas will be available at such low prices that the extra steam and dioxide engines would not pay for attendance, interest and depreciation. With very cheap gas the first thing is to make big engines, the next to make them so that they never break down, and the last thing, to make them efficient.

Dynamos.—As regards efficiency, we have reached the practical limit already; in fact, efficiencies are, perhaps, lower for large machines than in the best English practice of a few years ago. This is also true as regards output from a given size. We are limited by the hysteresis loss in iron, which prevents our using higher inductions in armatures, and low permeability which limits our field and armature tooth inductions. Nor are we likely to find a better available conductor than pure copper. As insulator we have mica. It looks, therefore, as if we were within sight of our limits in dynamo and motor designs.

Though dynamos are limited in speed, generally to that of the driving engine, it is possible to make a dynamo give an output corresponding to a much higher speed. Fig. 2 shows a way of getting a pressure corresponding to a high speed in a direct-current generator. The field has a number of N and S poles in succession, as usual in an alternator. The field is laminated. The armature is drum-wound as if for a two-pole field, and it has teeth which come opposite N poles on one side of the machine, and S on the other. A very small movement of the armature causes the positions of correspondence to change rapidly, so that the magnetic field rotates

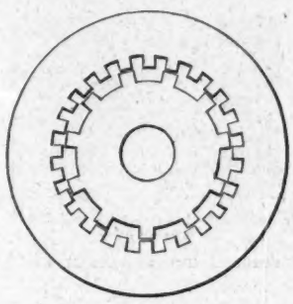


Fig. 2.—Rotary Field Direct-Current Dynamo.

rapidly. Thus, if there are 11 armature teeth and the speed is, say, 200 revolutions, the field rotates at 2,200, giving the corresponding pressure. If the field rotates with the armature the effective speed is 2,000; if the other way, 2,400. The difficulty in such a machine will arise from magnetic leakage. The armature reaction is also considerable. But reversing devices analogous to those proposed and used by Edison, Houston, Sayers, Atkinson, and others are available, and the machine may be made so that the armature largely excites the field in the case of a generator, and wholly excites it in the case of a motor. It is a question whether such a device as this may give us a light compact railway motor.

Transformers.—In alternating transformers there has been little room for improvements for the last 10 years. The "ageing" of the iron was a trouble, but now there seems little possible advance.

Secondary Batteries.—A further improvement in batteries may be expected to produce very great changes in important branches of engineering. We are practically limited to lead, at any rate in acid cells. Take first the plate that oxidises on discharge. It should not dissolve in the electrolyte, as if it does the deposition and solution will be uneven, and the plates will grow trees and come to grief. This puts zinc out of court, and iron is out of court for the same reason; there is no suitable electrolyte. On the other plate, not only must the depolariser be insoluble, but it must be converted into an insoluble body on discharge. The coating must be a conductor in one state or the other, or there will be no proper contact. In the lead cell there is always enough peroxide and metallic lead in the coatings to secure electrical contact, though the discharge product is an insulator. The depolarising coating must be connected to a conducting plate which is not attacked by local action. Lead and silver are the only available metals, and sulphuric, and perhaps phosphoric, the only acids, for the nitrate of lead is soluble, and hydrochloric acid is decomposed by lead peroxide. Lead is protected by its coating of sulphate, or peroxide as the case may be.* It thus seems as if we were limited almost absolutely to lead and sulphuric acid. It is wonderful that we have the lead cell at all. We owe it to the chance observation of Planté.

In an alkaline electrolyte such as caustic, such metals as iron, nickel, cobalt, and copper form oxides which are insoluble. The metals are thus electro-negative in caustic, like gold or platinum in acid. The electrolyte here acts merely as a conductor, as the dilute acid was supposed to act in the lead cell. The future of this type of cell is uncertain, as very little has been published as to results. Our limits in secondary batteries thus seem to be settled by the need of having insoluble electrodes and insoluble coatings.

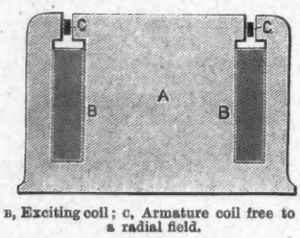
Cables.—The conductor itself can hardly be improved, but there is great room for improvement in the insulation. It is largely the insulation of the cables that limits our pressures, and therefore our distances of transmission. It is exceedingly unlikely that we have reached the limit in insulation. There is no branch of electrical engineering so important as cable making; yet there is no branch of the industry which is run on less scientific lines. Engineers do not know now whether rubber is better than paper, nor can they tell what any particular make of cable will be like after 10 years' use. We do not even know how to test a cable.

Apart from resistance to rupture and leakage, capacity and dielectric hysteresis are important factors. In alternating work capacity may produce very unexpected effects. The loss of power by dielectric hysteresis has again been discussed recently, and we do not seem to have arrived at anything like the lower limit of this yet.

Overhead bare conductors for very high pressure are not used in this country. There is a fairly definite limit to the pressure available. When the fall of pressure, or dielectric stress just round the wire exceeds the breaking-down value of air, the air is "torn" and discharges take place which involve considerable loss. This can be reduced by increasing the size of the conductor. It may thus pay to use aluminium or even zinc, or a combination, for very high pressure overhead power transmissions.

* See papers of the late Gladstone and Tribe, and Drake and Gorham.

Condensers.—There is generally excess of capacity on systems, so that the current leads relatively to the pressure, and there seems to be no demand for condensers. Bringing the poles of a large station within a small fraction of a millimetre over an enormous area, with nothing but a few thicknesses of paper between them, does not appeal to an engineer. A more mechanical form of condenser might be made, as in fig. 3, if it is ever wanted. A coil of



A, Field magnet; B, Exciting coil; C, Armature coil free to move vertically in a radial field.

FIG. 3.—ELECTRO-MAGNETIC ALTERNATING CONDENSER.

copper or aluminium is held in a strong radial field so that it is free to move at right angles to the field. If the equation of motion is worked out it will be found to behave like a condenser on an alternating current. I do not know how it would sound. Some 10 or 12 years ago I urged the use of over-excited synchronous motors for taking up idle lagging currents. This method is now used frequently, and it lessens any demand there might be for condensers.

Light.—Our chief work, until lately, has been producing light. Here the inefficiency and waste is prodigious, and though it is mostly unavoidable, there is still great room for improvement. We take great care over our stations, watching every penny from the coal shovel or mechanical stoker to the station meter. We quarrel over 1 per cent. in the generators. When we get to the mains we care less, and once we have got to the consumers' meters we care nothing at all.

Practically all light is wanted for use by the human eye. The human eye is exceedingly sensitive; it is calculated to see a distant star when receiving 10^{-8} ergs per second, so that one watt would enable, say, five thousand billion people to see stars with both eyes, but it would have to be used economically. The eyes reading a book in a fairly good light want something of the order of two ergs per second, so that a watt would only work the optic nerves of, say, the inhabitants of London. But the book, say, 200 square centimetres, would need about 3,000 ergs a second to illuminate it. A candle,* which gives a light of 4π, radiates about 0·2 watt, or five candles a watt; that is to say, at an efficiency of unity, we would get 5 C.P., or 20 π units of light per watt. The efficiency of a glow-lamp is only about 0·25 C.P. per watt,† or 0·05, so there is room for improvement. The obvious goal is direct production of "light without heat," by which is meant producing only the rays of wave-lengths which affect the eye. The firefly appears to succeed in this.

There is no thermo-dynamical reason why electrical energy should not be converted directly into radiation of any wave-length without loss; apparently our limits are practical—that is to say, it may be done, but we have not yet hit on the way of doing it. The vacuum tube appears to be a means of converting electric power direct into radiation. The Cooper-Hewitt lamp, for instance, gives an efficiency of about three candles per watt, or something like 0·6. Unfortunately the light is of a very bad colour. One method is to degrade the light by making it act on silk dyed with matters which lower the radiation to a redder colour by fluorescence.

The Standard Candle.—The standard candle, which ought to give a light of 4π, is about as absurd as the horse-power. The candle and the horse are about equally nearly obsolete, and the candle is about as likely to give a candle-power—or 4π units of British light—as a horse to give a horse-power. The horse has one advantage over the candle: he is not inextricably mixed up with the 4π controversy, and well-meaning people do not try to rationalise him as a unit.

† *Inverted Ratios.*—There is a curious tendency among engineers and other scientific men to get ratios wrong. People talk of efficiencies in "watts per candle"; "pounds of steam per horse-power-hour," a specially barbarous unit; insulation in megohms per mile; specific resistance in microhms per cubic centimetre; and muzzle velocity in foot-seconds; while elasticity is defined so that perfectly elastic means absolutely rigid. The "candle foot" and "candle metre" or "carcel metre" are now coming in to add to the unnecessary inaccuracy and confusion. It is sincerely to be hoped that we shall soon have light units in terms of watts and temperature of radiation, so as to fit into the C.G.S. system.

‡ See, for instance, "The Electric Arc," H. Ayrton, a valuable epitome of the work done on the arc lamp up to the present time, including the authoress'.

§ *Back Electromotive Force of the Arc.*—Ohm's law, $C = E/R$, is really a statement of a physical fact, namely, that if the other physical conditions remain constant, the ratio of C and E is invariable. It is not a mere definition, though it is a definition too. But if the physical conditions alter with variations of C, there is only left a definition of R, as being equal to E/C. We cannot by any measurements of E and C find out anything about the nature of R. If we choose we may write $C = E/R + e/R$, where e is defined as a pressure which may be negative, and R is defined as a resistance. Any attempt to determine R and e from measurement of C and E is merely an attempt to solve a single equation with two unknowns, which is absurd. If two or more sets of readings of E and C, E^1 and C^1 and so on are taken, a fancy definition of R and e may be given, so that $C = (E + e)/R$, $C^1 = (E^1 + e)/R$, &c., and if many readings are approximately consistent with constant values of e and R, they may be called electromotive force and resistance, but they are only fancy names, and have no physical meanings. A huge amount of labour has been devoted to trying to determine the resistance and back pressure of the arc in terms of E and R. I would urge that all this is an attempt to solve a problem which does not exist. Not only have innumerable experiments been made measuring C and E, but their ratios of relative increase are taken as if they gave further information. This involves exactly the same fallacies. Many of the methods involve making a change, say, in C, and assuming the arc has not had time to change accordingly, but the arc is too quick. The various ingenious arrangements with alternating or telephone currents, superposed on direct, or direct superposed on alternating, are of the same type. They combine the argument in a circle as to the definition, with an attempt to deceive the arc by taking measurements before the arc has time to feel the changes due to change of current. These considerations are urged with the view of possibly saving unprofitable work.

The Arc Light.—Most makers of arc lamps seem to devote their whole attention to the mechanism, and look upon the arc merely as a hot gap that has to be preserved by suitable apparatus. Many lamp makers, on the other hand, have records of exhaustive experiments on the relations of the pressure, current, and light with different carbons; but they are very seldom published. On the other hand, an enormous amount of laborious experiment on such points as these is available,‡ and on the back electromotive force of the arc.§ The physics of the arc, an exceedingly difficult branch of study, has not received much systematic attention yet. There are so many anomalies about the arc that one cannot say anything definite with safety. For instance, if the temperature is limited by the vaporisation of carbon, what must be the specific heat of vaporisation of carbon? Where does the vapour go to, and what happens to it in an enclosed lamp? In condensing into smoke, it should give light of the same colour as the crater. If it has an enormous specific heat, it ought to raise the other pole to crater temperature where it condenses. If it is a light gas, a large portion of its specific heat of vaporisation may go to external work. Most of the upper carbon is burnt away by external air; if a pencil to match the crater is volatilised it does not account for much power. If the vapour is very light, there must be large volumes from the upper carbon. Then what conducts? Carbon vapour alone, or mixed with a little monoxide or nitrogen, is a very good conductor at these temperatures. Does that go to show that carbon vapour dissociates like iodine or chlorine, &c.? The whole question of the physics of the arc deserves far more careful study than it has yet received, but the work is surrounded with difficulties, and is really a branch of the theory of the passage of electricity through gases—a matter of the greatest scientific importance.

Looking at the arc as analogous to a vacuum tube with no vacuum, but very hot and very rarified gases instead—a difference in degree, not in kind—the question arises whether we can get direct conversion into radiation without intermediate heating. The enclosed arc seems to give us something of this sort. It is difficult to see what goes on inside the inner globe, but the arc itself, apart from the crater, seems to give more light. The efficiency of an enclosed

From Ohm's law as a statement of a physical property of matter we get to regard resistance as a property in accordance with which $d\,H/d\,\theta = C^2R$; that is to say, resistance has come to mean a property by which electrical energy is degraded directly into heat—an irreversible process, while an electromotive force with a current means reversible change of electrical or mechanical or other power, or *vice versâ*. This difference, though I have never seen it formally stated, runs tacitly through science. Again, we may regard electromotive force as being produced only by lines of induction cutting the circuit, to take the crude conception. This is the same definition in another form, except that in the reversible interchange between chemical and electrical energy, magnetic induction is not generally considered. The behaviour of magnetic induction due to the movements and chargings and dischargings of ions has not been worked out in any publication, as far as I know, but it ought to be. Thermo-electricity is worthy of study from the same point of view.

Taking these definitions, and going back to the arc, it is clear that nearly all the power is spent at the crater. The drop of pressure may, therefore, be taken as being at the crater, so that the arc proper is nearly at the same pressure as the other carbon. If the change of electrical energy is directly into heat, as there is no reason to doubt, then it is due to resistance, and not to back electromotive force. On the other hand, the radiation from the arc itself is probably due to direct conversion of electrical power into radiation; that is to say, the gas does not radiate light because it is hot—gases at 3,000° C. do not radiate any light—but because the current affects the particles in such a way that they produce light. There are thermo-dynamical reasons for treating radiation as heat, but as the energy is not in this case first degraded to heat to heat the gas, and then radiated because the gas is hot, the radiation is caused not by resistance, but by back electromotive force. The molecular movements, whatever they may be, involve magnetic induction increasing or decreasing in the interlinked circuit in such a way as to produce a back pressure, the power spent in overcoming this back pressure going out as a continuous stream of radiation. This back electromotive force must be very small—nothing of the order of 40 volts, for instance.

arc is much reduced, however, by the deposit and globes. Hot vapours, such as that of metallic salts in the Bunsen flame, give out light by direct action, not because they are hot, but by some chemical change, and this holds good of vapours in vacuum tubes, and doubtless also in the arc. In an enclosed arc the carbon vapour, instead of combining with oxygen, may first condense at the temperature of the crater, forming a luminous envelope round the arc itself. By mixing suitable salts with the carbons we may thus expect to get electrical power converted directly into radiation. It has long been known that adding sodium salts to the carbons increases the light, perhaps without improving it, but such experiments have been carried out rather empirically, and apparently without any distinct idea of direct production of light.

We do not seem to have reached our limit as to light from pure heating, because we lose a lot of light into the opposite carbon. But, far more important than this, I would urge that the arc is not necessarily a hot body radiator only, but that it may also convert electrical power directly into light in the space between the electrodes, and this gives a chance of rising more nearly to our theoretical limit of about five candles per watt.

(To be continued.)

ON ELECTRONS.

By Sir Oliver Lodge, F.R.S., Vice-President.

(Paper read in London, November 27th, 1902.)

Introduction.

In Maxwell's *Electricity* published in 1873, Sec. 57, the following sentence occurs in connection with the discharge of electricity through gases, especially through rarified gases:—

"These and many other phenomena of electrical discharge are exceedingly important, and when they are better understood they will probably throw great light on the nature of electricity, as well as on the nature of gases and of the medium prevading space."

This prediction has been amply justified by the progress of science, and no doubt still further possibilities of advance lie in the same direction. The study of conduction through liquids first, and the study of conduction through gases next, combined with a study of the processes involved in radiation, have resulted in an immense addition to our knowledge of late years, and have opened a new chapter, indeed a new volume, of physics.

The net result has been to concentrate attention upon the phenomena of electric charge, and greatly to enhance the importance of a study of electrostatics. Not long ago Fitzgerald used chaffingly to speak of electrostatics as "one of the most beautiful and useless adaptations of nature"; and it was becoming the custom with teachers who felt that they must attend exclusively to the practically useful, and not waste their students' time on decoration and superfluities, almost to ignore, or at any rate to scamper through, the domain of electrostatics, and to begin the study of electricity with the phenomena of current, and especially of the connection between electricity and magnetism.

And certainly from the severely practical point of view, as well as from many other aspects, this part of electrical science remains the most important; but to him who would not only design dynamos and large-scale machinery, to him who in addition to the training and aptitude of the engineer possesses something of the interests, the instinct, and the insight, of a man of science, to such a one the nature and properties of an electric charge, at rest and in motion, constitute a fascinating study; for there lies the key to the inner meaning of all the occurrences with which his active life is so intimately concerned—there lies the proximate solution of problems which have excited the attention and taxed the ingenuity of philosophers and physicists and chemists since men began to escape from the struggle for bare existence—that most immediately practical of all occupations—and felt free to devote themselves, some to art, some to literature, some to the accumulation of superfluous wealth, and some to the gratuitous pursuit of speculation and pure theory.

Your president, Mr. Swinburne, realising that a society like this was sure to contain men eager to pursue their subject into some of the intricacies far removed from their immediately practical occupations, wrote and pressed me to come up and give an explanatory sketch of what had been done of late in the world of pure science towards the elucidation of the most familiar electrical processes; and with but little hesitation I consented, feeling sure that what the President urged would not be regarded by the Institution at large as out of place or unsuitable, though of my own motion I should never have thought of offering any such paper.

Part I.

First I must lay a basis of pure theory: we must consider the properties of the ancient and long known phenomenon called an electrified body.

Two substances placed in contact and separated are in general united more or less permanently by lines of force, the region between them being in a state of tension along the lines and of pressure at right angles. These lines have direction: they begin at one body and end at another, they map out a field of electrostatic force, and their terminations on one or other of the bodies constitute what we call an electric charge. Electric charges are of two kinds, one corresponding to the beginning of the lines, the other to their ends. To one class of bodies, called insulators, the lines appear rigidly attached; whereas in another class they slip easily along, and are transferred from one such conducting body to another in contact with it, with great ease. The tension in the lines tends to bring the ends together as near as possible, giving rise to what is observed as electrical attractions and repulsions.

In empty space, it is probable that the only way of destroying such a field of force is to allow the two bodies to approach each other, and thus shorten up the lines to nothing; though, even so it is not probable that the charg s are destroyed, but only approach so close, that they have no external effect at any moderate distance. When matter is present, however, it may be able to assist this collapse of the lines in various ways, giving rise to the various phenomena of conduction and of disruptive discharge.

If one of the two oppositely charged bodies is sent away to a considerable distance, while the other is isolated and regarded alone, the lines of this latter start out in all directions in nearly straight lines, giving rise to the simple notion of a single charged body, a thing which is no more really possible than is a single magnetic pole. The other ends of the lines must be somewhere, though they may be so far away as to be spoken of as, for all practical purposes, at infinity.

Now consider how far this field of force belongs to the body, and how far it belongs to space, that is to the ether surrounding the body. The body is the nucleus whence the lines radiate, but the lines themselves, the state of tension and other properties which they represent and map out, do not belong to the body at all; at each point of space there is an electric potential, and this potential represents something occurring in the ether and in the ether alone.

A Charged Sphere.—Picture in the mind's eye such a charged body, say a charged sphere, and let it change its position; how are we to regard the effect of the displacement on its field of force? Nothing in physics is more certain than this, that when a body moves, the ether in its neighbourhood does not move. The ether, in fact, is stationary; it is susceptible to strain, but not to motion; it is the receptacle of potential, not of locomotive kinetic energy.

The effect of the motion of the body, then, is to relieve the strain of the ether at one place and to generate it at another; the state of strain travels *with* the body, but *through* the ether.

Regarding the matter from the point of view of the ether, we might say that the field of force is constantly being destroyed and regenerated as the body moves. Regarding it from the point of view of the moving body, we should say that it carries its field with it.

The question now arises—and it is far from being an easy question—what sort of occurrences go on in the ether when this decay and regeneration of an electrostatic field is occurring, or when a field of force is moving through it? Can it adapt itself instantly to the new conditions, or does it require time? This matter has been studied, closely and exhaustively, by Mr. Oliver Heaviside.

Fix the eye upon a point a mile distant from the body; does the information about the motion of the body reach that point instantaneously, so that all the lines of force move like absolutely rigid spokes, every part simultaneously: and, if so, how is the communication carried on so that the distant parts of the medium can be thus instantaneously affected? Or does the disturbance only arrive at the distant point after the lapse of a small but appreciable time; in other words, has there to be an adjustment to the new conditions—an adjustment which reaches the nearest parts first and the further parts later; and if so, what additional phenomena can be observed during the unsettled period?

The answer is that during the motion of the charged body, and even after the cessation of its motion, until the disturbance has had time to die away and everything to settle down into static condition again, the penomena of *magnetism* make their appearance; a new set of lines of force quite different from the electrostatic lines (although they, too, exhibit a tension along them and a pressure at right angles) come into temporary being. These do not originate at one place and terminate at another; they are always and necessarily closed curves or rings, and in the present simple case they are circles all centred upon the path of motion of the charged body. At any point of space there are now three directions to consider:—(1) there is the original direction of the electrostatic field—the original electric line of force; (2) there is the direction of the motion—that is, a direction parallel to the movement of the charged sphere; and (3) there is the direction at right angles to these two; this last being the direction of the magnetic lines of force—the direction of the magnetic field.

I spoke of the magnetic field as temporary, but that is on the assumption that the charged body is merely displaced, moved from one position to another; if it is not stopped, but keeps on moving, then the magnetic lines continue as long as the motion lasts. Its strength at any point, r, θ, is:—

$$H = \frac{e\,u}{r^2} \sin\theta.$$

If we are asked whether such a magnetic field is weak or not, I have to reply that that depends entirely on how strong the charge is and how quickly it is moving. There is, in my opinion, no other kind of magnetic field possible; and so, if ever we come across a magnetic field which we feel entitled to consider "strong," we must conclude that it is associated with the motion of a very considerable charge at a velocity we may properly style great. But certainly it is true that for any ordinary charged sphere moving at any ordinary pace—even supposing that it is a cannon-ball shot from the mouth of a gun—the concentric circular magnetic field surrounding its trajectory is decidedly feeble. Feeble or not, it is there, and to its existence we must trace all the magnetic phenomena of the electric current.

For just as there is no electrostatic field save that extending from one charged body to another, so there is no electric current except the motion of such a charged body, and no magnetic field except that which surrounds the path of this motion.

The locomotion of an electric charge *is* an electric current, and

the magnetic phenomena surrounding that current are believed to be the only magnetic phenomena in existence. If any other variety is possible, the burden of proof rests on those who make the positive assertion.

One more statement:—While the charge is stationary everything is steady, and we have an electric field only. While the charge is moving at constant speed the current is steady, and we have a steady magnetic field superposed upon a steadily moving electric field, and a certain conveyance of energy in the direction of the motion.

But what about the intermediate stages, the stages of starting and stopping; what is the condition of things after the charge has begun to move but before it has attained a constant speed, and again when the brake is applied and the speed is decreasing, or when the direction of motion is changing? What phenomena are observable during the epoch of acceleration or retardation of speed or curvature of path? Something more than simple electrostatics and simple magnetism is then observed.

We get the phenomenon of induction—the generation of an induced E.M.F., of value at any point equal to the rate of change of the lines of magnetic force there. There being no conductor, this E.M.F. will propel no current, but it will represent an electric force which was not there before, and in a new direction, perpendicular to the direction in which the growing magnetic lines are moving, which is outwards from the charge. Consequently the new or induced E.M.F. points in the direction of motion, though in the sense opposed to any change in it; and the effect of its superposition upon the magnetic field is to cause a certain small transmission of energy in a radial direction out and away from the accelerated charge. Some energy therefore flashes away with the speed of light, though in ordinary cases an exceedingly small amount.

It is from an electric charge during its epochs of acceleration or retardation that we get the phenomenon called radiation; it is this, and this alone, which excites ethereal waves, and gives us the different varieties of *light*. The energy radiated per second is $\frac{2\mu e^2 \ddot{v}^2}{3v}$, where v is the speed of light and $\ddot{v}$ is the acceleration of the charge e.

Thus, or rather by means of a very extensive development of these fundamental ideas, are all the phenomena of electricity and optics summarised, and, so to speak, accounted for.

Electric Inertia.—Whatever a charge may be, and whatever the hydro-dynamic constitution of the ether, it must be able to maintain electric lines and magnetic lines, and to transmit energy wherever both sets of lines cross at right angles.

An accelerated charge is equivalent to a changing current, for $\frac{dC}{dt}$ may be written $\frac{d^2Q}{dt^2}$. Whenever a current changes we have an E.M.F. of self-induction set up equal to $L\frac{dC}{dt}$.

Considered from the point of view of a current constituted by a moving charge, this corresponds to a mass acceleration.

And the electrical acceleration is opposed by the E.M.F., just as the acceleration of matter is opposed by its mechanical inertia. The coefficient of the electric acceleration represents, therefore, an inertia term, and is properly called electric inertia.

By Lenz's law the effect of induction is always to oppose the cause which produced it. In the present case the cause is the acceleration or retardation of the moving charge, and so in each case this is opposed by the reaction of the magnetic lines generated by it.

Motion is opposed while it is increasing in speed, and it is assisted while it is decreasing in speed—an effect precisely analogous to ordinary mechanical inertia;—and therefore force is necessary, and work must be done, either to start or to stop the motion of a charged body. An extra force, that is, by reason of its charge. Whatever the inertia the body may have, considered as a piece of matter, it has a trifle more by reason of its being charged.

The value of this imitation or electrical inertia for the case of a charged sphere of radius a is:—

$$\frac{2\mu e^2}{3a}.$$ (See appendix.)

Since this is very important, I repeat:—Just as a changing magnetic field affects an electrostatic charge, that is to say, generates a feeble field of electric force, into the intensity of which the velocity of light enters squared in the denominator, so it is with a changing electric field, it generates a magnetic field proportional to its velocity of change; and if it is being accelerated, the magnetic field itself varies, and in that case generates an E.M.F. which reacts upon the accelerated moving charge, and always in such a way as to oppose its motion—by what is called Lenz's law, or simply by the law of conservation of energy; for if it assisted the motion, the action and reaction would go on intensifying themselves until any amount of violence was reached.

The magnetic lines generated by a rising current, that is, by a positively accelerated charged body, react back upon the motion which produced them in such a way as to oppose it—to oppose it actually or elastically, not passively or sluggishly, as by friction. The reaction ceases the instant the motion becomes steady; it is not analogous to friction therefore, but to inertia; it is the coefficient of an acceleration term.

The magnetic lines generated by a falling current, that is by a negatively accelerated or retarded charged body, react oppositely and tend to continue the motion: thus here also we have a term corresponding to inertia. And the charged body may be said to have momentum by reason of its charge while it is moving. The value of the momentum is proportional to the velocity, so long as the velocity is not excessively great, and accordingly the inertia term is constant, and independent of speed, under the same restriction. It may, therefore, be considered to be in existence even when the charge is stationary, and thus it simulates exactly the familiar mechanical inertia of a lump of ordinary matter.

In an appendix will be given the simplest form of the quantitative relations here indicated, and the inertia due to an electric charge will be calculated. It is to be understood that whatever inertia a material sphere may possess, considered as matter, it will possess more when it is charged with electricity, and this, no matter whether the charge be positive or negative. The amount of extra or electrical inertia is proportional to the electrostatic energy of the charge; that is to say, it is proportional to the charge and its potential conjointly. Call the charge e, and the radius of the sphere a, the potential will be $e/\kappa a$, and the appropriate inertia is $m = \frac{2}{3v^2} e \cdot e/\kappa a$, where v is the velocity of light.

Another way of putting it is to say that if a mass of this amount were moving with the speed of light, its kinetic energy would be half as great again as the potential energy of the electric charge when standing still; for $\frac{3}{4} m v^2 = \frac{1}{2} e \cdot \frac{e}{\kappa a} = \frac{1}{2} Q V$ = potential energy.

Now any appreciable quantity of matter, even a milligramme, moving with the speed of light, has a prodigious amount of energy; namely, for the mass of one milligramme, 15 million foot-tons. Or as Sir William Crookes has expressed it; a gramme, or 15 grains, of matter, moving with the speed of light, would have energy enough to lift the British Navy to the top of Ben Nevis. Consequently the inertia of any ordinary quantity of electric charge must be exceedingly minute. Notwithstanding this, it is quite doubtful whether or not there really exists any other kind of inertia. The question whether there does or not is at present, strictly speaking, an open one; though to my mind it is practically closed.

The only way of conferring upon a given electric charge any appreciable mass is to make its potential exceedingly high, that is, to concentrate it on a very small sphere.

A coulomb at the potential of a volt has an electrostatic energy of half a joule, that is, $\frac{1}{2} \times 10^7$ ergs. The mass equivalent to this would be

$$\frac{2}{3} \frac{10^7}{9 \times 10^{20}} = \frac{2}{27} \times 10^{-13} \text{ gramme} = 10^{-8} \text{ milligramme.}$$

Raise the potential to a million volts, and the mass equivalent to a coulomb at that potential would be the hundredth part of a milligramme; still barely appreciable therefore.

The charge on an atom as observed in electrolysis is known to be 10^{-10} electrostatic units. If this were distributed uniformly on a sphere the normal size of an atom, viz., one 10^{-8} centimetre in radius, its potential would be $\frac{1}{100}$ of an electrostatic unit, or about three volts. The energy of such a charge would be 10^{-12} erg, and the inertia of a body which would possess this energy if moving at the speed of light would be 10^{-33} gramme.

But this is incomparably smaller than the mass of a hydrogen atom, which is approximately 10^{-25} gramme. Consequently the ionic charge distributed uniformly over an atom would add no appreciable fraction to its apparent mass.

If, however, the atomic charge were concentrated into a sphere of dimension 10^{-13} centimetre, its potential would be 1,000 electrostatic units or 300,000 volts, its energy would be 10^{-7} erg, and its inertia 10^{-28} gramme, or about $\frac{1}{1000}$ of the mass of a hydrogen atom.

All this is a preliminary statement of undeniable fact; that is to say of fact which follows from the received and established theory of electricity, whether such things as electrons had ever been found to exist or not.

All that we have stated is true of an ordinary charge on any ordinary sphere which can be made to move by mechanical force applied to it.

It gives us the phenomena of electrostatics when at rest, of magnetism when in motion, of radiation when started and stopped, and it incidentally, by reason of the known laws of electro-magnetic induction, exhibits a kind of imitation inertia, and in that way simulates the possession of the most fundamental property of matter.

I will add a few more closely connected assertions. Apply a sufficiently violent E.M.F. to a charged sphere, and the charge may be wrenched off it.

Insert an obstacle in the path of a violently moving charged sphere so as to stop it mechanically with *sufficient* suddenness, and again it is possible for the charge, or something like it, to be jerked off it and passed on. But to do this the speed of the sphere, as well as the suddenness of stoppage, must be excessive. Usually the charge is merely thrown into an oscillation, when the sphere is suddenly stopped; and it then emits a solitary wave or spherical shell of thickness equal to the diameter of the sphere: or greater than that diameter by the amount the sphere has moved during its retardation. When the acceleration is moderate, however, the radiation is less energetic and also less intense: less energetic because its power depends on the square of the acceleration, less intense because it is spread over a thicker ethereal shell. Röntgen rays are perceptible only when the speed was great and the stoppage so sudden that the wave or pulse shell is strong and thin.

The doctrine of the behaviour of a charged sphere in motion, and the calculation of the value of the quasi inertia of an electric charge,

was begun by Prof. J. J. Thomson in an epoch-making paper published in the *Philosophical Magazine* for April, 1881—one of the most remarkable physical memoirs of our time.

The stimulus to this investigation was supplied by those brilliant experiments of Crookes, published in the *Philosophical Transactions* for 1879, which were preceded by observations of Plucker and Hittorf, and followed by other observations by Goldstein and Puluj and others in 1880.

In 1891 Sir William Crookes was your President, and in his inaugural address expounded further some of these brilliant experimental investigations, to which Schuster and many others had contributed. It is not too much to say that up to the time of Crookes the phenomena of the vacuum tube were shrouded in darkness, notwithstanding much laborious and painstaking work done both in this country and on the Continent in connection with them; but that since the researches of Crookes in the seventies, the theoretical luminosity of the vacuum tube has steadily increased, until now, as Maxwell predicted, it is shedding light upon the whole domain of electrical science, and even upon the constitution of matter itself.

(To be continued.)

Birmingham Local Section.

On the 10th inst., Mr. Henry Lea, M.Inst.C.E., the chairman for this session, delivered an address upon "Recent Progress in Electrical Industry in Great Britain."

The period selected for showing the growth or otherwise which had taken place, was from the beginning of 1898 to the end of 1901, four years. Steam engines for driving dynamos for producing electricity for all purposes were first considered. Nineteen firms had replied to the questions asked, and the largest firms in the country were included. Although the totals could not be taken in any sense as the total of the country's productions, they might fairly be regarded as representative of the industry generally. The following results were given:—

Numbers Total b.h.p. and Average b.h.p. Engines Turned out for the Sole Purpose of Driving Dynamos.

Year.	Number of engines.	Total b.h.p.	Average b.h.p. per engine.
1898	967	86,000	89
1899	1,649	168,000	102
1900	1,655	210,000	127
1901	1,836	295,000	161

From the Table it will be seen that not only has the total h.p. increased tremendously, but that the average power of the engines has increased 81 per cent. in the four years. The increase in the total b.h.p. for the same period was 243 per cent., while the increase in the actual number of engines was 90 per cent.

Mr. Lea then turned to the question of output of dynamos and motors, taking first direct current machines. The number of firms who furnished returns was only 17, and the chairman remarked that electrical firms seemed much more reticent as to their outputs than were the makers of engines. The figures for this side of the industry were given as below, viz.:—

Year.	No. of d.c. dynamos and motors.	Total power in kw.
1898	2,540	39,300
1899	4,736	65,200
1900	5,095	83,600
1901	6,799	107,400

The number of machines for 1901 showed an increase of 168 per cent. over 1898, while the output in kw. showed an increase of 174 per cent.

The next item dealt with was alternating current machinery. It was stated that manufacturers of this class of machinery were comparatively few in number, and as regards three-phase work, had not been long engaged in the production of such machines. Grouping together single, two and three-phase machines, the following returns—from five firms only—showed the numbers and power of generators and motors combined:—

Year.	No. of machines.	Output kw.
1898	35	9,322
1899	37	8,974
1900	39	8,209
1901	77	8,165

The figures given by Mr. Wyld in 1901 before this local section were quoted, viz.: that 16 installations of polyphase plant had been installed in this country in the last four years, aggregating some 10,000 h.p., while the Manchester Stuart Street station, containing 15,000 h.p. three-phase, and the Willesden two-phase plant, amounting to 10,000 h.p., were brought forward as instances of the increased adoption of polyphase machinery. The conclusion was drawn that, although nearly all of this polyphase machinery was imported from abroad, yet the day was fast approaching when the bulk of it would be manufactured in this country.

In traction work, progress has been more marked, perhaps, than in any other branch. In 1898 the route mileage was 365, and the number of cars was 2,117. In 1901 the figures had increased respectively to 777 (an increase of 112 per cent.) and to 3,821 (an increase of 73 per cent.). The capital invested in 1898 was £9,800,000 by companies only; by 1901, municipalities had entered the field, with the result that they had invested over 10½ millions sterling, the companies having, at this time, invested 19¾ millions, making a total invested capital of over 30¼ millions, and an actual increase of 210 per cent. since 1898. Mr. Lea, who reported upon the surface contact system for the Wolverhampton Corporation, said that the service was a successful one, and that, so far, it had given every satisfaction. At first there had been a little trouble, as was usual in all new undertakings, but the cause had been ascertained and removed, and the line had since given great satisfaction. The crucial test would be a severe winter, with plenty of snow and salt.

Some interesting observations were made about the ultimate displacement of the steam locomotive. The reason why the railway engineers had not made steam locomotives to travel at 100 miles per hour was because they had not been asked to do so. It was not, as was frequently stated, that the employment of reciprocating parts prohibited the use of steam engines for these speeds. With trains of the same length as the proposed mono-rail, and on a perfectly straight track, a modern locomotive with driving wheels 8 ft. 8 in. diameter could attain a speed of 100 miles per hour.

A long description of the general uses for electricity at a railway station, and an account of the Crewe plant for lighting and power purposes, &c., were given. Interesting lantern illustrations were shown of the signal cabins at Crewe, where the levers are worked by electricity; the largest cabin—which is also the largest in the world—is one containing 350 levers.

The last section of the address dealt with measuring instruments, and the many improvements made during the last four years were described. Perhaps the most interesting instrument which had been brought out was Mr. Duddell's oscillograph. Mr. Lea gave a demonstration of the working of the instrument. This consisted of a series of experiments showing, among other things, the process of synchronising two alternators.

The form of the synchronising current wave was shown, and by altering the field strength of one alternator, it was observable that the power factor was increased and the current reduced, while it could also be seen how the current came into step with the E.M.F. The demonstration aroused the keenest interest.

THE SUGDEN WATER-TUBE BOILER.

The latest form of large water-tube boiler is that which we illustrate on the following page, the invention of Mr. Thomas Sugden, a boiler expert of 30 years' experience in boiler insurance engineering and manufacture, a Whitworth scholar, and inventor of several valuable and successful accessories connected with steam boilers.

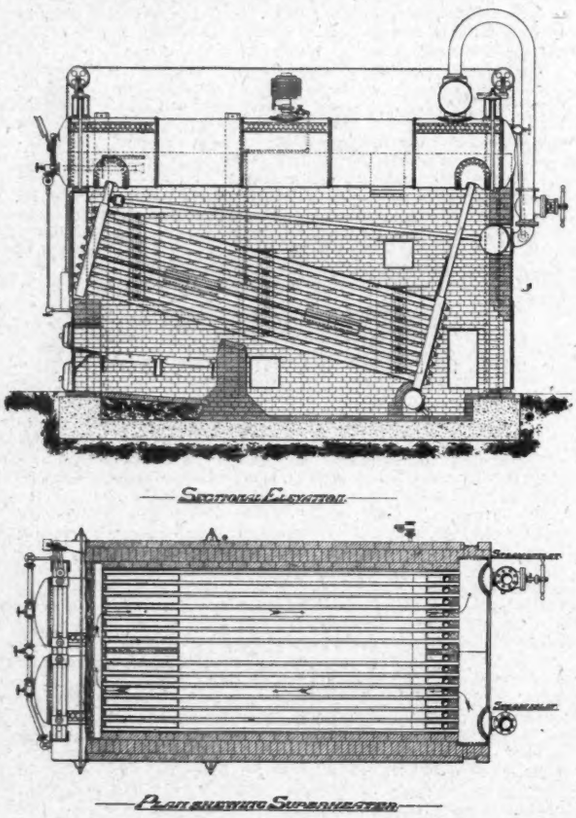
The "Sugden" boiler, while not departing from well known general lines, embodies improvements of an important character for providing means for more efficient circulation of the water, better fuel combustion and improved furnace arrangements to render the heating surface more effective, one object kept in view being the better prevention of smoke. The boiler is constructed in sections, and straight headers are employed with tubes placed immediately over each other; also the baffles are placed horizontally.

Water-tube boilers, as hitherto constructed, require approximately about 50 per cent. more heating surface than Lancashire and similar types of internally-fired boilers for the same amount of water evaporated, thus indicating the fact that a given amount of heating surface in a Lancashire boiler is more effective than the same amount of heating surface in a water-tube boiler. For example, a Lancashire boiler, 30 ft. × 8 ft. diameter, has 966 sq. ft. of heating surface; this boiler will evaporate under fair conditions of draught and fuel, say, about 7,000 lbs. of water per hour. To evaporate this amount in a water-tube boiler, at least 1,600 sq. ft. of heating surface is required. The reason for this difference in efficiency of heating surface is, to a large extent, due to the method of abstracting the heat from the furnace. In the case of the Lancashire boiler, an area of only a few square feet of heating surface is presented to the flame immediately over the fire, whereas in a water-tube boiler about one-third of the heating surface of the boiler is placed directly over the fire, the effect of which is to cool the gases below the point of ignition, and in this way it is possible for gases which have not by any means produced their full quantity of heat to pass away into the main flue. Instances have occurred where such gases have become ignited by means of a stray spark, and have burst into flame after passing into the flue, on the way to the chimney.

Water-tube boilers are constructed somewhat after the manner of a surface condenser, and if provision be not made for absorbing the heat gradually, the furnace gases become too quickly chilled. One of the objects aimed at in the design of the "Sugden" boiler is to render the heating surface more effective and to prevent unconsumed gas from passing into the flue. This is provided for in the arrangement of the furnace whereby the gases are made to travel longitudinally over the tubes, that is, in the direction of the length of the tubes. The heating surface is divided into three chambers or compartments, by means of horizontal baffles. The bottom baffle is pierced with a number of slots or openings immediately over the furnace where the fire is hottest. Through these slots a small proportion of the flame and heated gases is allowed to escape direct into the second chamber, the bulk of the gases, that is, about 90 per cent., passing along the tubes in the first chamber towards the rear end, and thence into the second chamber. Any gas which, in contact with the large amount of heating surface in the first chamber, has been cooled below the point of ignition

before combustion, now comes into contact with the numerous flame jets from the first chamber, and is re-ignited. In this way the gases are more effectually consumed.

A further advantage of the arrangement is that the flow of gases is horizontal. The gases completely envelop the tubes, thus preventing the accumulation of soot on their upper surfaces. The usual deposit of soot on the top side of the tubes renders the heating surface much less effective, and this deposit is always made where the gases strike water-tubes at right angles to their length. Where the gases move in the direction of the tubes, there is no useful purpose served by placing the tubes in "stagger." The effect of a straight header is to secure a freer circulation of the water, its course not being impeded by the resistance of a tortuous passage. The importance of free circulation is not sufficiently recognised, and probably many tube failures arise from this cause. The course of circulation is that of least resistance, and water may circulate chiefly through the upper rows of tubes, while in the lower rows, where the water cannot get away so quickly, circulation may be deficient, and steam being imprisoned in the tubes at intervals, may cause overheating and consequent tube failures. A straight header wherein water can move freely provides a safeguard against overheating and failure of the lower tubes.



The Sugden Water-Tube Boiler.

As regards smoke prevention, the furnace is so arranged as to admit of the correct principle of firing being adopted, viz., supplying the fresh or green fuel at the front and maintaining a white-hot fire at the rear of the grate. The smoke from the fresh fuel passing over the incandescent fire is ignited and consumed with the air admitted for the purpose. In boilers of ordinary construction where the gases escape vertically from the fire grate, it is impossible to avoid making smoke, for the design is bad both in theory and in practice. The one and only way of burning smoke effectively is to pass it over the incandescent fire as described, while mixed with the air necessary to ensure its combustion.

Sugden's improved superheater is shown in the above illustrations. The chief features of this are straight tubes of uniform length and diameter, no joints in the fire, and no flooding water required during the process of raising steam.

The use of flooding water is open to very serious objections owing to damage from neglect to blow off the flooding water before turning on steam to the engines, and to leakage of water through the flooding cock, as well as to incrustation in the tubes, which results from the evaporation of the flooding water, thus rendering the heating surface ineffective and the tubes liable to burn out. Steam from the boiler enters a drum at the rear end of the superheater. This drum is divided into two compartments, one being the inlet and the other the outlet to the superheater. The inlet side communicates with a series of tubes, which convey the steam to the front end of the boiler into a header connected by a similar series of tubes to the second division, that is, to the outlet of the superheater drum, whence the steam passes along to the main steam pipes.

The superheater tubes are arranged as shown in the illustration to intercept the heat from the flame and furnace gases in such a manner as not to be exposed to the more intense heat immediately over the fire. A relief pipe is provided which discharges the superheated steam into the boiler when steam is first being raised, thus causing steam to circulate through the superheater tubes. This pipe is provided with a valve, which is operated by mechanism connected to the stop valve so as to be fully open when the stop valve is closed, and closed when the stop valve is open.

With respect to the construction of the headers, these, instead of being welded as usual, are made of solid-drawn steel.

The Sugden boilers and superheaters are manufactured by Messrs. Galloways, Ltd., of Manchester, who have put down special tools for the purpose. Some of these contain special features which are improvements upon anything hitherto done in this direction.

IMPERIAL TELEGRAPHIC COMMUNICATION.*

By CHARLES BRIGHT, F.R.S.E.

(*Continued from page* 1004.)

It should be taken as an axiom that no reduction of rates will pay at first, matters improving only gradually as the public becomes aware of the advantage afforded them. This view, however, is evidently not shared by the associated companies; for in the year 1886, the late Sir James Anderson, (managing director of the Eastern Co.,) in the course of a paper to this Chamber remarked, "If they were to lower their tariff to 2s. to India and to 4s. to all other places beyond India, the companies would lose more than half their present revenue." As we know these reductions have, under stress, since been partially reached without any signs of the disaster referred to.

It may be remarked incidentally, that, in answer to recent public calls and partly due to a wiser handling, the companies referred to have, of late, shown definite signs of pursuing a more enlightened policy, for besides waiving the question of subsidies where before they were said to be essential,† they have lowered some of the rates to a material degree. This, however, is no doubt largely due to distinct suggestions of State or other competition, as well as to the various inquiries recently set afoot at the instance of agitation and pressure brought about by Sir Sandford Fleming, Sir Edward Sassoon, Mr. Henniker Heaton and other energetic statesmen. Besides the reduction of rates to Australia and other places, resulting from the Pacific cable project, the separation of the British and foreign offices at Hong Kong and Shanghai and the ultimate extension of the Cape—Australia cable to Adelaide, are all cases of the dictates of critics being eventually acted upon after being for a considerable time derided as unreasonable, unnecessary, impracticable, and, indeed, "involving penury" to the companies. Then, again, the eventual solution of that mystery, the Indian rates, only came about through Sir Edward Sassoon's persevering inquiries. By some extraordinary circumstance the Eastern and Indo-European Companies were "most desirous of a reduction," but Russia and Germany were said to object.

Other similar proposals are being made now that evasion appears impossible, and no doubt some ingenious explanations of all these reforms is available; but we see the effect of agitation and how much is due to those who have agitated. It would seem as though fair and square business competition is what is really wanted.

Very strong arguments should, however, be necessary to induce any Government to compete with private enterprise.‡ The State should, on the other hand, exercise on behalf of the public taxpayer an *effective control*, rather than otherwise interfere with industrial undertakings.

Looking to the future, it appears abundantly clear that the Government are not only perfectly entitled morally, but that it is also their duty to watch over and protect the interests of the public by putting a limit on the rates to be charged by telegraph companies when the latter seek subsidies, or, at any rate, landing rights.§

* An address given before the London Chamber of Commerce on Thursday, December 4th, 1902.

† A somewhat large subsidy—£34,000 a year—was asked by the Eastern Extension Co. for the new lines to and from the Cape to Australia, but the laying of this was ultimately agreed upon without any subsidy whatever, before the Government had actually settled on the Pacific cable. A reduction of tariff was volunteered at the same time.

‡ The Pacific cable only became necessary as a Government concern because the companies responsible for our cables to Australasia were not prepared to meet requirements. Under such circumstances no company could reasonably expect to be protected against Government or other competition.

§ To place the existing rates on a proper footing *at once*, especially if there is any idea of encouraging competition rather than otherwise, strictly speaking, a special Act of Parliament should be introduced for the purpose of their adjustment. It is, however, difficult to recognise the justice of such a course under the particular conditions that have prevailed up to date; moreover, it is questionable whether a Bill with this end in view would ever pass.

A sliding scale tariff dependent on, say, a standard revenue, might be found possible—on the gross receipts, not on the net profits, which cannot readily be checked. Or, again, the rates might possibly be based somewhat on the average earnings for a given period.* A guarantee of traffic, either on the laying of a cable or on a reduction of rates, would, in future, be preferable to the payment of large subsidies. Another useful reform would be that of the general adoption of a class of "deferred messages" at special and reduced rates, as already in use in India and other countries. At present only 5 per cent. of the messages sent are of a private, or domestic, character; but if deferred rates came into vogue for employing the cables through the night, the number of such messages might be very largely increased. Moreover, speculative inquiries about prices and quotations would then become a more general subject for telegraphy. The proof that there is ample room for the deferred rate system rests in the fact that the companies say that if they were adopted nearly all messages would go on that basis. It is not unlikely that the deferred rate system will be accepted as feasible if sufficient pressure be brought to bear, though possibly the International Convention may again be made a stumbling block. Legislation must be introduced if necessary to prevent a company from charging another system excessive rates for forwarding on messages with a view to avoiding competition—that is to say, to put a stop to what are known as "blocking" rates. Then, again, the Government might take occasion to bargain with companies for reduction of rates in one direction when granting landing rights in another. An indemnity might also be imposed for every day's interruption to communication above a certain number. This is better than applying anything of the sort to the duration of time occupied in actual repairs. This is a point, however, which should not be pressed, for a number of alternative routed cables between given spots is more essential and would probably meet the requirements. In the public interest the Government ought also to guard against subsequent financial amalgamations, absorptions,† or joint purses, besides providing for taking over any given cable (at an expert's valuation) at any time, if found desirable.

Further, it is a question whether exclusive landing rights should be granted, unless on very definite and favourable conditions. Wherever competition is excluded to the benefit of any particular interests, a corresponding advantage should be secured by the Government on behalf of the public. In any case, exclusive rights should be capable of being terminated if found desirable, and should never in future be made permanent.‡

The result of reduction of tariffs would probably, as a matter of fact, eventually tend to an increase of revenue rather than otherwise. Had the companies a little more recognised the principle of opening up a country and its trade (in the same way that railways do without subsidies), and popularising "the cable by low rates—on the principle of creating a demand," and allowing that telegraphy tends to re-act on trade—they would very likely have done even better than they actually have done, and would not have had practically all the Chambers of Commerce on their trail, besides the Colonial Office following up various complaints from almost every corner of the Empire. It is possible that the reason the companies do not want to lower their rates is because if they did so they would require to increase their staff§ and possibly the number of lines between given points.‖ The latter reason is, as a matter of fact, a strong argument in favour of reduced rates from the strategic and taxpayer standpoint. At present, cablegrams are never sent by private individuals except under great stress—indeed, the cable is hardly thought of by them¶—and messages would be sent on a much larger scale by small business houses if the rates were materially lowered. This still more applies to the Press—most important clients—who might, with cheaper rates, do so much to bring the Empire into closer touch, politically, commercially, and socially. The popularising of the cable might be effected partly by reducing the rates for above a certain number of words, if further alternative lines be laid, the effect being an encouragement to business cablegrams covering more ground. But what we really want—and what, perhaps, we shall some day get—is a universal 1s. rate for all cables throughout the Empire.

Meantime, anything in the shape of lower rates and an increased number of cables on different routes to carry the increased traffic would be good commercially, politically, and strategically. If the Government would guarantee the companies for a given period against loss, the experiment might be agreed to, I imagine.

Let us now turn to the strategic aspect of alternative lines on different routes. This has often been misrepresented. For instance, those who have advocated the ordinary trade routes as the best routes strategically for cables, have, by way of backing up their contention, laid stress on the fact of our men-of-war being on the spot. But it should be remembered that in the event of a "surprise war," our communications with the rest of the Empire *vid* the Mediterranean would probably be cut off before war was actually declared.* For that very reason it should be similarly worth our while to render such an achievement out of the question beforehand, and that is best accomplished by increasing the number of our telegraph *routes*, and of making future cables further out of the reach of naval powers. As things stand at present, in practically every case the enemy could only effect interruption to our traffic by more than one line being disturbed at the same time. This would probably always involve more than one European Power being against us, but it would be a possibility to be reckoned with in the event of a "surprise war." As a matter of fact, it could always be effected in the absence of one of our battleships from the right spot at the right moment in both cases. Rapid communication with her fleets at foreign stations is an absolute essential, indeed, for a power in command of the sea at, and previous to, the outbreak of war.

If it happened that France and Russia† were combined against us, Russia would at present be in a position to cut off our communications with India and Australia in the Mediterranean,‡ besides interrupting the systems of the Great Northern Telegraph Co. on the one hand, and the Indo-European Telegraph Co.§ on the other, whilst France paid her attention to the systems *vid* the African East and West Coasts respectively, as well as the European landlines and the cables in the English Channel. The mere fact that the associated companies are in the habit of setting aside a part of their reserve fund for war risks clearly indicates that they do not really consider their cables safe in time of war. The companies, however, contend that strategic cables could be laid "to order" as required. This undoubtedly might be practicable, though often difficult to accomplish: but if we recognise the likelihood of our communications being interrupted before war has been declared, we are here again presented with the spectacle of "locking the stable door after the horse has been stolen." As a matter of fact, in many instances it would be several weeks, if not months, before the missing link could be restored, during which time the effect might be disastrous. In this argument, too, the companies appear to forget, for the moment, the scarcity of gutta-percha, so often referred to by them.

Some students of the subject have suggested that the cutting of neutral cables is contrary to international law; but Article XV. of the Convention on the freedom of belligerents, arrived at during the International Telegraph Conference held at Paris in 1884, seems to pretty well dispose of that argument. In any case, we know from experience that cables undoubtedly would be cut in time of war, in spite of all conventions or international laws, which would, indeed, be a broken reed for a great commercial nation, like Great Britain, to lean upon in the event of war with other naval powers.‖

Then there are those who consider that a line which touches on foreign soil can readily be converted, at short notice, into an "all-British" line, by a change of route, in the event of war. Of course, such a thing might be done with a successful issue; but the risk is great, and the result is liable to be less satisfactory in any case than an "all-British" line "ready made," which is a matter of paramount importance, irrespective of any commercial view. The suggestion that such "all-British" lines should be made "to order" as required, seems to indicate an admission as to the utility of this class of line, though the suggestion has been made by those who

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* A certain rate per mile is an obvious standard; but this, for the reason that the tariff has to be arranged on the basis of probable traffic volume, and that the shareholders' outlay has also to be considered, would not always be fair. Probably the best *rough* standard at present existing is the Atlantic tariff, for here competition, more or less severe, is in force; and, on the other hand, English Atlantic companies have had no actual subsidies.

† These, though having certain advantages from an economic administrative point of view, are liable to lead to abuse of power, besides defeating wholesome competition.

‡ This is based on an approximate estimate of the life of a cable, a very ordinary period being 25 years. Sometimes it is only 20 years; but this has been exceeded in several instances; and, in at any rate one instance, the period has been made indefinite, *i.e.*, permanent, notably in that obtained by the "Eastern" Co. from the Khedive for telegraphic communication with Egypt. Somewhat similar considerations appear to have been secured by the companies from Turkey and Persia.

§ At the present time, the "Eastern" group of companies employ a staff at home and abroad amounting to about 2,000, exclusive of the 700 odd who are attached to their fleet of 12 cable repairing ships.

‖ In other words, though they might in the end earn as much revenue by reduced rates, it would give them a great deal more trouble to effect this.

¶ It is doubtful whether many know which course to pursue when wishing to send a cablegram.

* It must be remembered that a power which is friendly to-day may be unfriendly to-morrow; in fact, with the present state of foreign politics, there is no knowing who we may not have against us any day. In this connection may be quoted the words of a worthy opponent to "all-British" cables—Lieut. Carlyon Bellairs, R.N.:—"There is no strategical reason for avoiding landing cables on foreign soil, *except the possibility of being at war with the power owning the territory in question.*" I have underlined the last part of Mr. Bellairs' sentence, because it appears to me to give away his argument altogether.

† It is known that Russia has for years had carefully prepared schemes for cutting off our communications to the East and Far East, and the same applies to France.

‡ During the bombardment of Alexandria this actually *did* occur.

§ This company has, it is believed, recently had foreign clerks forced upon it in Germany and Russia.

‖ In this connection, let us quote the words of Colonel Sir G. S. Clarke, K.C.M.G., F.R.S., when discussing Lieut. Bellairs' recent paper at the United Service Institution. In the course of his remarks, Sir George said:—"I do not attach very much weight to the point about the non-liability of cables connecting a neutral and belligerent to be cut except in the belligerent's territorial waters. There is no international agreement at all as to the status of cables in war such as will protect them. In the Convention of 1888 we kept entirely clear of all attempts which other Powers were ready to make, to obtain some recognition of the neutrality for cables."

argue that cables are least liable to disturbance in time of war if landed on foreign territory of various nationalities.* Certainly a shallow water "all-British" line would be more prone to cutting if we were at war ourselves; but, on the other hand, any strategic cable should be laid in *deep* water, if possible.

Moreover, the secrecy secured for the "all-British" line—an advantage applying in times of peace as well as during war—is an advantage which exists in no other class of cable. This advantage is sufficiently great even to counterbalance any greater chance that may exist, under given (common) circumstances, of its being cut if this country were engaged in war. Though it is quite true it is impossible to foresee the precise seat of any future war this country may be engaged in, surely it is well worth being prepared for an emergency beforehand, in, at least, any likely quarter. That is evidently the conclusion that our Continental neighbours and the United States have arrived at already as regards cable communication.

Lines laid for strategic reasons meet their requirements best if laid in deep water, *with few landing places*,† on out-of-the-way (non-trade) routes—their exact course, except at the ends ‡ being unrecorded § in the open, broad ocean, where they are admittedly difficult, even for a cable ship to find, and even when the route is actually known. Moreover, a knowledge by the enemy of the position of a cable in deep water ‖ is a far less serious matter than when laid in shallow water. A man-o'-war can pick up and cut a cable in shallow water, just, as it is equally true, she can probably more easily repair a cable here, but without long lengths of actual cable-grappling rope, and the necessary fitting-up machinery, she cannot do much with a deep-water cable.¶

One of the few reasonable points against "all-British" cables is that of setting the backs of Europe, as well as the United States, against us. But this has been practically discounted by the fact that France and Germany, in addition to our American cousins, are now going in for similar precautions themselves—initially on account of the cables of the world being British-*owned*.**

A stock argument sometimes brought up to show that "all-British" cables are not necessary from the point of view of secrecy of messages, is based on the value of the cipher code in this connection. Surely, however, it is a mistake to rely on the security of the cipher, or any code, when we know by experience that the most difficult cipher can be translated if a sufficient number of messages are available to work on, together with a knowledge of the correspondent's identity, and the probable nature of his communications.†† Apart from this, the mere fact that messages passing through foreign territory are subject to serious, and often intentional, inaccuracies and delays is a sufficient argument in favour of "all-British" lines. Cables landing on foreign shores are, it should be remembered, largely worked by the clerk of the country even in times of peace; and if trouble were in the wind, the confiscation of the telegraph office would probably be effected previous to the declaration of war. That would not be likely to occur in the case of a cable landed on British territory, and certainly not if in any sense guarded.

The telegraph companies have, very naturally, paid their first attention to the trade routes as giving the best prospects of revenue; but these are not good routes strategically, wherever the cable passes through shallow water in the vicinity of foreign territory. The class of cables whose object is mainly strategic, have seldom been laid, for the reason that they are liable to be non-paying; but we should recognise them as a necessary policy of the age at almost all hazards; and it is just these lines that the State should first consider the advisability of itself laying, if necessary. Considering what we pay for our postal sea service, this view should be readily accepted; for, obviously, no country requires strategic cables so much as the British Empire, with its far-reaching possessions.

If certain strategic cables were laid, the traffic on the ordinary trade routes would be less liable to become disorganised in war time by the suppression of code messages. The typical strategic line, avoiding foreign soil, has been materially assisted by a recent invention. By its means long sections of *expensive typed* cable can be avoided when an island, however small, can be found on the route, for the apparatus to be inserted between the ends of the incoming and outgoing cable for purposes of a system of re-transmission which dispenses with the necessity of a large staff of operators for effecting the same manually.

But the reason for which we require "all-British" cables in addition to international lines does not rest merely on strategic grounds. We need them for consolidating the Empire, politically and socially, as well as for the assistance of Imperial trade. The companies have already provided a fair network of cables on trade routes; but direct "all-British" lines are now required if only to ensure speedy and united "cabling" facilities with the whole of the Empire in times of peace and war. If we could render the entire British Empire practically as one country, by means of telegraphy, a great result would be achieved.

For commercial trade reasons the more links on various routes the better to ensure communication in all directions at all times; and at least one of these routes should, for the various reasons enumerated, be "all-British." At the present moment, the "all-British" element in the now existing girdle is broken at two spots only—Madeira and St. Vincent, both Portuguese territory; and though Portugal may be regarded more as an ally than as a possible enemy, it is also true that no belligerent would hesitate to consider so feeble a neutral power, the fact being that the value of a cable landing on neutral territory all depends upon circumstances—that is to say, what the neutral power is and the condition of politics at the time. The complete "all-British" chain might be completed by a cable from Ascension (or Sierra Leone) to Barbadoes or Jamaica, where it would meet the cable coming from Canada. Time does not permit me to go into the various useful cable routes that should be taken in hand; but I will only mention that—partly in view of future trade between Canada and the Cape—a useful "all-British" line might be established between these countries either *vid* the West Indies or by a more direct route, connecting up with the "all-British" Atlantic cable that I have already spoken of as a link with the Imperial Pacific line.

There are other lines more urgent for strategic reasons which the Cable Communications Committee have taken note of. A difficulty in getting funds voted for purely strategic cables exists owing to the Treasury having so many calls for immediate indispensable and, indeed, vital needs, and purely strategic cables never appear under this head until too late.

A few words now regarding the broad question of State absorption of our cable system by special Act of Parliament. Whilst there can be no question that from the public point of view there is much to be said in its favour, it must be remembered that there are many unfavourable features about any step which tends to check private enterprise in a country the secret of whose greatness may be said to be largely due to that very function. There are also political objections to State absorption. Hitherto, the companies have acted somewhat in the capacity of diplomats—hence, perhaps, one of their objections to "all-British" lines. On the other hand, it must be recognised that the State, in having no shareholders to consider, should have less difficulty in serving the public satisfactorily in certain particulars. Wholesome competition, however, usually meets that objection to private enterprise, with the additional advantage that, as a rule, business men, with the necessary special experience, manage such matters better than Government officials with their numerous and varied duties.

As before stated, guarantees in some form, of traffic or revenue, might be found a convenient shape for Government encouragement to take with reference to any future lines. This would be a sort of compromise between granting a subsidy more or less large and giving no support whatever. The principle also seems better; and would, perhaps, avoid too close an examination into the question of fair profit by the companies. It is already in Government operation with the Indian railways.

Though, mostly for diplomatic and political reasons, the balance of evidence and argument may be against immediate, or complete, State absorption and monopoly, it would seem that—in the absence of the existing telegraph companies adopting the suggestions or dictates of the State—the Government would be entirely justified in encouraging competition as they would also be in setting afoot certain State lines, strategic or otherwise. The effect of this could be made to cover any desired reduction of rates, it being assumed that the existing rates could scarcely be adjusted by Act of Parliament.

From a strategic point of view, as well as from a general maritime standpoint, Great Britain and Ireland should be provided with a complete system of telegraphic communication round the entire coast, in communication with various inland centres and military stations. It is a piece of work which could best be dealt with by *wireless* telegraphy, in preference to overhead lines or coast cables, which latter fail owing to abrasion against rocks, kinks, &c.* Government might well encourage progress here by establishing funds for further experiments such as may produce really practical and reliable results.

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* It would not do to rely on all countries showing such consideration for neutral cables, even for international reasons, as the United States appear to have during the Spanish-American war. It must be remembered that control and censorship fairly covered their requirements, and that the water was deep.

† Interruptions to cables by bonfires on the beach have already been effected more than once. Landings should be guarded.

‡ Notice of the approach of cables within two or three miles from the shore is, of course, a necessary provision against damage by anchors; moreover, it would be impossible to maintain secrecy at such distances from the landing end, just as also any attempt at foul play could easily be detected and remedied here.

§ To meet this end, it would be better that the Intelligence Departments concerned should have no large scale charts with the cable course marked thereon. The present custom of reporting home the position of the ship when laying cable and the length paid out should, for similar reasons, be abandoned in the case of a strategic line.

‖ Throughout their war with Spain, the Americans were never able to cut all the Cuban cables landing at Santiago, owing to the deep water there.

¶ If the Navy went in for properly equipped telegraph ships, with a staff of cable engineers and electricians, the matter would be different, of course.

** France decided upon establishing communications with her possessions before "all-British" lines were seriously contemplated or talked of.

†† A good example of how codes are read when desired, is the reading of the Spanish code by the Americans on the Havana Key West cable during the recent war. That cable was left intact for this express purpose.

* This matter was gone into by the writer very fully in The *Engineer* of February 17th, March 3rd, March 10th and March 17th, 1899, in the course of a series of articles on "Coast Telegraphic Communication."

Some of you may have been wondering why I talk of cables in view of the existence of wireless telegraphy. The answer is that—apart from low speed and lack of secrecy—at present wireless telegraphy can, at most, only be relied upon in such cases as the one I have just referred to, together with that of ship and light-house signalling; and the immediate question in connection with this new invention is, how we can get it under control from a single centre?

(To be concluded.)

ELECTRICITY AS A COMPETITOR OF GAS.*

By W. R. RAWLINGS, A.M.I.E.E.

I do not wish you to expect from me any hostile criticism of our competitors, but it is my desire to draw your attention to some of their methods. The gas companies have, through their various advertisements, endeavoured to show that electricity is extravagant and injurious; in contrast to this, we find the respective electric lighting concerns content with their knowledge of the superior quality of their products, and relying solely on the energies of contractors to promote their business. The difference between the business methods of the gas and electricity companies is one of the reasons which prompted me to speak on this subject.

The gas companies have lately inundated most householders with pamphlets and other literature containing writings and extracts by various authors; the wording is arranged in all cases to influence public opinion. If the gas companies had merely pushed their own products, we should say nothing about it; but as they go to such extremes as I will mention, there is good ground for comment.

One smartly covered booklet is issued by the Gas Light and Coke Co. (the most important suppliers of gas in London), and bears the title of "A Ray of Light: Gas and Electricity Compared for Householders and all Sorts and Conditions of Men," by T. Ebenezer Pye. Starting from the "introductory," we have this heading: "Expert Reports—Errors Arising therefrom and Why—Theory *v.* Practice." The author goes on to say that he "has been practically engaged *in both* industries, and is therefore—from the experience gained—in a position to submit authentic information relative to each system." Again, he says, "comparative statements as put forward by experts and as understood (or more generally misunderstood) by the lay reader, are often absolutely misleading. Serious error usually creeps into the conclusions arrived at from calculations which are based upon theoretical data only," and he concludes the introduction thus:—"Every effort has been made by the writer to ensure that the information here following shall be, as far as possible, absolutely reliable. In the comparisons given of the two systems, the advocate for electricity will certainly find no cause for complaint, and readers may have confidence that the case for gas has been rather under, than over, stated."

Well, as a reader, I must say I have not much confidence in this author's work. Whatever he might know about gas, he has still to learn the A B C of electricity, for he informs us that "the Board of Trade unit (B.T.U.) of electricity is a kilowatt," that is, 1,000 watts of electrical energy," and that "a 16-c.p. lamp takes approximately about 60 watts of current per hour."

He now asks us to believe his figures, which follow. The figures are many and result in alleging that a 1,000-c.p. incandescent gas light costs 2½d., and that the same light by electricity costs 15d. in a given time, or nearly seven times as much as gas. This, however, is modest compared with the advertisement of the Incandescent Gas Co., who allege the cost to be 10 times more than gas, and also when compared with an example given in another book (as 13 to 1), to which I will refer later.

Now, after this theoretical "proof" that electricity costs seven times as much as gas, he gives us some "practical illustrations" showing the cost to be less than three times. Why should not his "practice" show seven times?

Following these "practical illustrations," we have something more interesting, namely, "hygienic considerations." He says, "A black deposit from a gas flame always indicates a waste of gas, due to improper and incomplete burning."

Such an assertion seems to be almost an insult to the designers and makers of gas burners, and I am afraid that if all gas people think as this gentleman writes, it will be a long time, if ever, before they will learn how to avoid the black deposit. I thought it was well known that a black deposit was caused by the carbonising of the particles of matter in the air by heat from any source. The author refers to this, but quite spoils his case by the statement referred to.

After the ingenious excuse of blaming the construction of the gas burner, there follows:—"A Pertinent Question."—The question for the reader now to decide is therefore:—"Is it better, with the help of the gas flame, thus to have these solid impurities deposited on the ceilings out of harm's way (they are also to a great extent sterilised), and to occasionally clean them away? or to retain them in the air for human consumption, to be deposited in due course in the lungs during the process of respiration?"

I call the foregoing "simply lovely."

After this he quotes the *Lancet*, which is reported to have said:—"The amount of carbonic acid gas in the combustion of coal gas is quite insignificant compared with that exhaled by the human individual. Of the two the human exhalation is much the more prejudicial to health."

We all agree with the latter part of the quotation, but I cannot understand the *Lancet* using the former words, because it is, I believe, well known that an adult gives off about 0·6 cub. ft. of carbonic acid gas per hour, which is about the same as is given off by 1 cub. ft. of coal gas properly consumed; therefore each gas burner using 4 cub ft. of gas per hour would equal four adult persons in rendering air unfit for breathing. As a practical fact, we all know that one gas burner used in an ordinary room very soon makes one feel a desire to walk outside for purer air.

The author claims absence of heat owing to induced circulation of the air and consequent ventilation. This is another erroneous statement, because it is quite a common practice for people to burn gas in the daytime, to warm rooms, &c.

He continues:—"By taking them (gas burners) away, and substituting the electric light, the conditions may be, and probably in many instances are, more comfortable than before, but the serious atmospheric conditions previously made abundantly manifest by the heat from the gas flames, and thus calling loudly for improvement—not unchanged as before, but a thousand times worse than before, and none the less so because of the enhanced comfort which leads to no further trouble being taken or investigations made. The old trouble is left to fester unsuspected and the foul air to become fouler still, owing to the removal of the corrective operation of the gas flame."

Despite his former claim of absence of heat, you will notice that, in the foregoing quotation, he uses the heat of his gas burners as the foundation for his statement on ventilation, and, with all his practice, he overlooks a few important points, not the least of which is the loss of window space to shop-keepers. With electric light a window and the whole of the shop may be utilised from floor to ceiling, but with gas, provision must be made for the heat and products of combustion, usually entailing the loss of quite 3 ft. of the upper part of the premises. It does not matter how good the combustion may be, there is always water, carbonic acid, and a little sulphur given off, which form an acid solution, and destroy decorations, leather goods, such as book bindings, boots, &c., and also all brass and other metal work, even to the gas fittings themselves, and there is not a ceiling which will pass reasonably clean for two years where gas is employed. The author speaks further of ventilation, which he thinks necessary in spite of his former statements, and says, "There is only one way of overcoming this difficulty, and that is by the employment of fans; the motive power for this purpose may be either from gas engines or electricity according to circumstances." I cannot say that anyone would appreciate a gas engine for running a domestic ventilating fan, where electricity is available.

Further in this booklet, he sets forth the beauty of the gas flame, and argues that it cannot be an objection because "Where fancy and other perishable goods are liable to damage by vapours arising from gas flames, ventilation is often a necessity." The book finally closes with "A Summary of Rival Claims," stating that "The two systems have now been discussed fully and fairly," and sums up with these words, namely:—

"Efficiencies are shown to be about six to one in favour of gas."

"Damage caused by gas lighting, practically nil."

"Advantage in respect of convenience and safety."

The arguments are so thin, that I am sure you would consider it a waste of time if I were to give my views in reply.

The Commercial and Wandsworth Gas Companies also issue the book before referred to, and the last named issues another bearing the title of "Gas *v.* Electricity." "Which is the cheaper and better light?" I will ask your attention to a few of the choice passages, namely:—

"It is not necessary to explain what watts are, there are 1,000 of them in a Board of Trade unit."

"If you want 1,000 c.p. at one time, you will *require* 4,500 *watts per hour*."

"An absolutely fair and accurate comparison is:—Gas at 2s. per 1,000, you can afford to pay three-tenths of a penny per unit. If you are paying 3s. for gas you can afford to pay ½d. per B.T.U."

"Gas at 3s. for lighting will cost £1 5s."

"Electricity at 6d. will cost £16 17s. 6d."

From this so-called "absolutely correct" comparison the deduction shows the cost of electricity at 6d per B.T.U. to be 13 times dearer than gas, and with electricity at 4d. per B.T.U. to be nine times dearer than gas. Following this "comparison" there is a statement of so-called facts, where he quotes a Mr. Wyman, of Islington, giving his experience with gas at 3s. per 1,000 cub. ft. and electricity at 7d. per B.T.U. for first hour, and 6d. for second hour, and 4d. for subsequent hours. Taking the average cost per B.T.U. at 6d., we find that this consumer owns to results very different to previous assertions, namely:—

Two incandescent gas burners giving 120 c.p. cost for gas £2 6s. 1d. for 12 months.

Four 16-c.p. and eight 8-c.p. electric lamps, totalling 124 c.p., cost for electricity £10 9s. 6d. for the same period, or about 4·5 times more than gas, which is very different from 13 times, as previously quoted.

In this practical comparison there are only two gas burners employed as against 12 electric lamps, which would, of course, give a much better distribution of light, besides permitting economy by reducing the amount of light to suit the needs of the consumer.

It is this point of distribution of light that forms the crux of the whole problem, and if it happened that an example was taken of say, a small house of several rooms, &c., requiring 12 points of light, we should have a result quite contrary to the gas company's quotation.

* Abstract of paper read before the London Electrical Contractors' Association, December 2nd, 1902.

In the case of a new Board School recently opened at Morecambe, gas was beaten on the question of price. When the question of lighting was taken up by the School Board, the gas manager estimated that with all the lights on at once the gas bill would work out at 19s. per hour; Mr. Pape, on the other hand, quoted 7s. 6d. per hour under the same conditions. When the work was tested, the cost per hour with all lights on, worked out only at 6s. 3d. The cost of gas at Morecambe is 3s. 6d. to 3s. 11d.

If the gas company could produce a mantle burner of equal efficiency to their present one, but giving about 8-c.p. only, then we, engaged in electric lighting, would indeed have a strong competitor, but until the advent of such a small and efficient burner, we are sure of the lead with economy in our favour, apart from other considerations.

(To be continued.)

WIRELESS TELEGRAPHY IN FRANCE.

By E. GUARINI.

(*Continued from page* 922.)

M. Blondel's theoretical and practical researches in wireless telegraphy, more especially with regard to the coherer, are very numerous. The Blondel coherer (fig. 14) is well known. It is the one that the writer uses for experiments in which precision is required, and the one which he used for his Brussels—Mechlin—Antwerp experiments and for several other observations. The Blondel coherer has, as we know, a reserve chamber of filings, with which the sensitiveness of the coherer can be regulated by placing

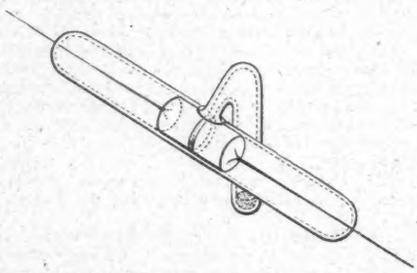

Fig. 14.

upon it a more or less fine layer of filings (generally a very fine layer). In 1900, by the aid of his sensitive coherers, M. Blondel was able to keep up communication from the environs of Paris to a distance of 13½ km. with antennæ of 24 m. M. Blondel's name is also connected with the application of the telephone to wireless telegraphy, and with the use of vacuum tubes in this connection. In a sealed communication, No. 6,041, laid before the Paris Académie des Sciences, August 16th, 1898, and entitled "Improvements in Wireless Telegraphy," which was opened in May, 1900, M. Blondel recommended the use of a telephone with coherer, and a process of

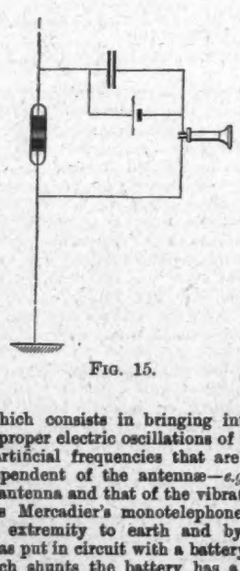

Fig. 15.

synchronisation which consists in bringing into accord, not the frequencies of the proper electric oscillations of the transmitter and receiver, but two artificial frequencies that are much lower, quite arbitrary, and independent of the antennæ—*e.g.*, the frequency of the charges of the antenna and that of the vibrations of a selective telephone, such as Mercadier's monotelephone. A vacuum tube connected by one extremity to earth and by the other to the antenna (fig. 15) was put in circuit with a battery and a telephone. The condenser which shunts the battery has a variable capacity, and serves to regulate the system.

The receiving circuits of different frequencies can be connected on the terminals of one tube (fig. 16), but it is better to connect them with different tubes placed on separate antennæ. In this way one station can correspond simultaneously with any number of other stations, and the signals will escape the observation of any station not tuned to receive them.

M. Tommasi has proposed a mode of preventing the interception of messages between two wireless telegraphy stations. This arrangement (fig. 17) is based on the very doubtful assumption that the distance of transmission increases with the length of the spark. It consists in setting in action, for the purpose of influencing a given receiver, two transmitters, one, *i.e.*, the one with the shorter range, continuously, which would render the messages undecipher-

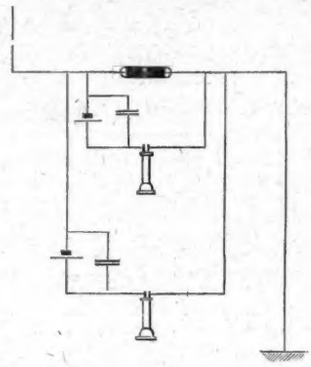

Fig. 16.

able within its range. This arrangement, admitting all that M. Tommasi asserts, does not prevent any receiver placed at any point in the circumference having for its radius the distance between the two stations from being influenced.

M. Jégon has also proposed an arrangement for localising the reception of signals, or, to speak more correctly, for preventing, if desired, an intermediate station from receiving signals not intended for it.

The Jégon arrangement (fig. 18) is based upon the fact that the zone of action of a given transmitter is more extensive in proportion as the antennæ of the transmitting and receiving stations are higher.

The receiving apparatus includes two coherers instead of one. A bobbin, which acts as a kind of transformer, comprises three windings; two of these windings are similar, but in opposite directions, and they are each connected with one of the coherers; the third winding, which is formed of a finer wire, is connected with the relay used. If the coherers are both influenced by an emission of waves, the currents of the same intensity conveyed by them

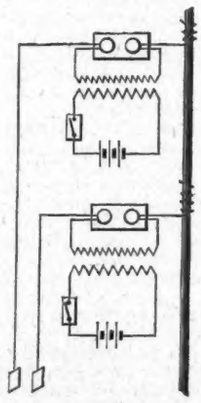

Fig. 17.

(in opposite directions in the two similar primary windings of the bobbin) produce no induction in the third winding, and the relay remains at rest. If, on the contrary, one coherer only is affected by the waves emitted, only one of the primary windings is traversed by a current; an inductive action is produced in the third winding and the relay is influenced. Thus, the relay is influenced when only one coherer becomes sensitive to the electric waves, and remains undisturbed when both are acted upon. An intermediate station does not receive any signals because the two coherers are influenced, whereas the end station receives them because only the coherer connected with the longer antenna is influenced. M. Tissot has made a number of experiments and observations on the French coast, more than we can enumerate here. Moreover, many of his observations have not been published. One very satisfactory arrangement tried by M. Tissot is that shown in fig. 19, which, within certain limits, guards the receiving apparatus against atmospheric electricity. One antenna is connected to earth, on the one hand, through an inductance coil, and on the other, through a condenser and a coherer placed in circuit, as usual.

The average distances to which vessels provided with the Tissot-Rochefort apparatus have been able to communicate are 40 and 50 miles, either between one vessel and another, or between a vessel and a station on the coast. M. Tissot has installed several stations on the coast of Brest, at Ushant, Pointe de St. Matthieu, Bec du Baz, Pointe du Château, &c. M. Tissot thinks that his

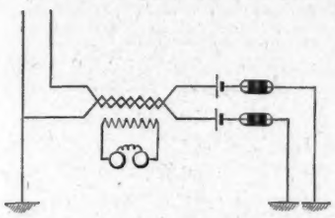

Fig. 18.

system of syntony is only partially successful, but sufficient to prevent the signals of different vessels from being mixed up. At the time when the German Fleet was passing Ushant, the French vessels that were provided with the Tissot-Rochefort apparatus were able, whilst communicating with one another, to read the signals sent out by the German vessels, and M. Tissot frequently intercepts signals sent out by English vessels or from the Marconi stations at Lizard Point.

The Popp-Pilsoudski receiver tried between two villas at Vésinet and Paris in July, 1901, consists of a coherer connected by one end

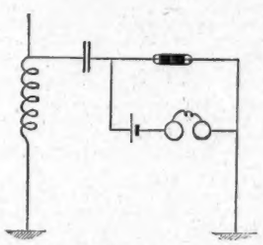

Fig. 19.

to the earth, and by the other to a plate parallel with the ground, from which it is insulated. The same arrangement is used for the transmitter, the oscillator in this case taking the place of the coherer.

The writer has tried the Popp-Pilsoudski system with plates having a surface 2 metres square, and although he used a very sensitive Blondel coherer and a very powerful transmitter, he was not able to communicate further than 20 metres. He had taken

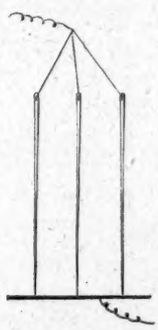

Fig. 20.

precautions to avoid the direct action of the transmitter on the receiver. Some time ago the walls of large and small towns in Belgium were placarded with staring financial announcements by the Société Française des Télégraphes et des Té éphones sans fil; that company which while it displayed the motto "*France d' abord*," came to Belgium to seek for the capital which France did not seem willing to furnish. These advertisements promised miracles, dividends of 15 per cent. or even more, and communications to distances of thousands of kilometres over land, by means of the famous new Branly coherer. The whole thing reduces itself to the use of the tripod—for Mr. Branly is the inventor of a Branly tripod which, when used in wireless telegraphy, constitutes, according to various journals, a receiver many times (40 it is said) more sensitive than the coherer constituted of filings. This coherer (fig. 20) which is based on experiments and principles that have long been known (see the works of Sir Oliver Lodge), consists of three needles resting on a metal tray (contact of an oxidisable metal with one that is not capable of being oxidised).

(To be continued.)

NOTES ON AMERICAN INSTALLATIONS.

By FRANK BROADBENT, M.I.E.E.

Power Equipment of the Great Northern Grain Elevators.*

The new grain elevators erected at West Superior, Wis., said to be among the most completely equipped of their kind in the country, are electrically operated by three-phase motors, driven from an isolated generating plant. The generators deliver energy at 440 volts, 60 ~, and do not call for further comment.

The atmosphere in old granaries, whilst storage operations are being carried on, is often so dust laden with a very fine, almost impalpable, dust, that any motors subjected to it must necessarily be totally enclosed.

The writer has been through machine galleries when it was impossible to see a naked gas light at a distance of 6 ft., and the engineman, who was wearing a gag over his nose and mouth, said it was comparatively clear, and "you ought to have been down half an hour earlier, when it was thick."

In the Great Northern granaries a complete dust collecting system is installed requiring in the aggregate over 200 h.p. The fans collect all the dust from the various floors and deliver it to the boiler furnaces, 250 ft. distant.

Each elevator leg is operated by an induction motor which drives a countershaft by ropes, the countershaft driving the elevator head-shaft through a raw hide pinion and cut-spur gear. Raw hide pinions have not been adopted extensively over here for large powers up to the present; although for small powers up to, say, 10 or 15 h.p., they are very generally used for geared motor drives.

The rope drive is on the single endless rope principle, such as was, at one time, frequently used for dynamo driving on ship lighting installations. Instead, however, of the jockey pulley being placed above and guiding the rope across from the last groove on the driven to the first on the driving pulley, it is placed in this instance between the top and bottom ropes, the rope from the last groove on the driving pulley being taken round the jockey and back over to the first groove without touching the driven pulley. This makes a very compact arrangement, and permits of a considerable amount of slack being taken up by moving the jockey pulley along its guides. There is nothing to be gained by giving a list of the motors used, as, without fuller data than is given in the descriptive article, nothing can be learnt as to the efficiency of the machinery. The aggregate motor rating is 2,750 b.h.p. As a guide to the powers required for this class of work, the following figures from the writer's notes of some tests made on an elevator in the Midlands may be useful:—"One motor, driving through belting and shafting two 60-ton and one 30-ton elevators 100 ft. lift; two distributing bands 50 ft. travel × 18 in. wide; and a passenger lift for two people. With one 60-ton and the 30-ton elevator, together with the two bands fully loaded, the power taken was 230 volts × 60 amperes, or, say, 16 b.h.p." As there is 10 actual h.p. in the lift alone, the belting, shafting and motor, air friction and cable losses only account for 6 h.p., so the efficiency of the whole system is 62½ per cent., not a bad result. In another test, one 60-ton elevator for discharging lighters, with a raising and lowering arm 30 ft. lift; one 60-ton elevator lifting 50 ft. to weighing machine; four reels or screens for cleaning grain, all working fully loaded, took 230 volts, 70 amperes, or, say, 19 b.h.p. For this class of work, necessitating great starting torque and a constant speed, shunt motors, with series starting turns, are advisable. The series turns should be cut out by the starting switch after all the starting resistance has been cut out.

Electric Motors in Cement Making Works.

At the Alsen Portland Cement Works, near New York,† an electric power plant has recently been put down, furnishing an excellent example of the adaptability of the electric motor to the severe requirements for this class of work. The boiler plant consists of four water-tube boilers, each of 300 h.p., working at 150 lbs. per sq. in. The draught is obtained naturally by a chimney, 210 ft. high. Three Corliss cross-compound engines, each direct-connected to a 400-kw. 250-volt generator, running at 90 r.p.m., constitute the main generating plant. There is also a direct-connected 100-kw. set running at 200 r.p.m. Coloured marble is used for the switch-board. The circuit fuses are at the back of the board, and the switches are provided with illuminated name plates placed in front of openings cut in the marble, behind which pilot lamps are placed. There are 51 motors scattered throughout the works, having an aggregate horse-power of 7,500, which is about 40 per cent. more than the horse-power of the engines.

Generally speaking, the motors are of the slow speed type, direct coupled or geared to the individual machines. The couplings are of a flexible type, and the gears are protected with planished iron dust-proof covers, which are easily removed for the inspection of the gear. The lower half of the gear case is a heavy casting, permitting the gear to be run in oil. The motors are all subject to considerable overloads, particularly at starting. To prevent sudden current rushes at starting, the multiple switch type of starter is used, in which a separate switch is used to cut out each section of resistance. An overload circuit break is fixed above each starting switch, provided with a time-limit device to prevent its operation during the starting-up process.

* *Western Electrician*, May 3rd, 1902.

† *Electrical World and Engineer*, N.Y.

A very interesting feature is the method of operating the electric drills used in the quarry, situated at a distance of about half a mile from the works. Current is conveyed by means of overhead wires to the quarry, where a direct current motor drives an alternator of low voltage and low frequency from which the drills are operated. The drills are provided with double solenoids, which are alternately energised, drawing the drill and spindle up and down through the coil. The drill is rotated by means of a rifled rod, ratchet and pawl.

NEW PATENTS, 1902.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, to whom all inquiries should be addressed.

26,409. "Improvements in lighting public thoroughfares, streets and places with electricity, gas and other illuminants and apparatus therefor." J. T. Pearson. December 1st.

26,416. "Improvements connected with railway and tramway points operated by or from the vehicles, and in points or switches for use upon overhead conductors of electric railways and tramways furnished with points." December 1st.

26,419. "Improvement in electrostatic voltmeters." G. W. Walker. December 1st.

26,420. "Improvements in switchboard frames." J. G. Statter. December 1st.

26,428. "An electric railway engine and appliances attached thereto. No overhead wires or underground or ground appliances required." H. C. Mayer. December 1st.

26,448. "Improvements relating to secondary or storage electric batteries." E. C. McKinnon. December 1st.

26,455. "Improvements in electrically-operated railway or tram rail point shifters and the like." C. A. Meatchem. December 1st.

26,468. "Improvements in fuse boxes." W. H. Flood and A. E. Honey. December 1st.

26,476. "Improvements in or relating to overhead conductors for electric railway and like systems." C. de Kando. December 1st. (Complete)

26,477. "Improvements in or relating to rotatory current motors connected in cascade system." C. de Kando. December 1st. (Complete.)

26,508. "Improvements in or relating to guide ropes for trolley poles for electric cars." J. Millar. December 2nd.

26,512. "Improvements in perforators, more particularly for use with automatic telegraph transmitters." J. Gell. December 2nd.

26,553. "Improvements in current-operated receiver for electro-magnetic waves." R A. Fessenden. December 2nd. (Complete.)

26,557. "Improvements in and relating to electro-magnetic traction increasing devices." A. A. Honey. December 2nd. (Complete.)

26,585. "Improvements in signalling apparatus for telephone systems." W. P. Thompson. (C. E. Egan, United States.) December 2nd. (Complete.)

26,586. Improvements in or pertaining to ships' telegraphs." H. F. W. Lucke. December 2nd.

26,615. "Improvements in fastening attachments for electro-plating and other purposes." F. G. Faulkner. December 3rd.

26,647. "Improvements in electric recording instruments." E. A. Carolan. (The General Electric Co., United States.) December 3rd.

26,668. "Improvements in and connected with controlling arrangements for electric motors and motor circuits." The Johnson-Lundell Electric Traction Co., Ltd. (R. Lundell, United States.) December 3rd. (Complete.)

26,673. "Improvements relating to devices for the measurement of electrical energy." H. H. Lake. (R. Arno, Italy.) December 3rd.

26,706. "Improvements in and relating to electrical resistances." E. N. Bray, R. F. Markham, F. E. Reiss and Bray, Markham & Reiss, Ltd. December 3rd.

26,717. "Electric locomotives." J. Swinburne. December 4th.

26,718. "Improvements in dynamo-electric machines and motors." J. Swinburne. December 4th.

26,735. "Improvements in electric light pendants and electroliers." C. W. Kemp. December 4th.

26,737. "'Cable clip' for drawing electric cables into conduits or pipes." G. K. Nowlan. December 4th.

26,746. "Improvements in electric motors." B. G. Lamme. (Date applied for under Patents Act, 1901, December 26th, 1901, being date of application in United States.) December 4th. (Complete.)

26,764. "Improvements in regulating electric generators." H. Leitner and R. N. Lucas. December 4th.

26,818. "Improvements in incandescent electric lamps and in collars for the same." N. Clemmison. December 5th.

26,822. "The hoop self-acting and electric motor." T. Burns. December 5th.

26,868. "A new or improved device for use in or with electrolytic apparatus." A. Wright. December 5th.

26,870. "Alternating current motor." M. Deri. December 5th.

26,876. "An improved system for the electrical transmission of type-recorded messages." W. S. Steljes and The Typewriting Telegraph Corporation, Ltd. December 5th.

26,877. "Improvements in and relating to coin freed machines for giving electric shocks." The New Polyphon Supply Co., Ltd. and A. Ficker. December 5th.

26,899. "A method of including mica in the insulation of cables for transmission of electrical energy." T. H. Vigor. December 6th.

26,906. "Improvements in junction frog plates for use on the overhead system of electric tramways." D. B. Foster. December 6th.

26,917. "Improvements in switching mechanism applicable for intercommunication telephone systems." M. Byng and G. L. Anders. December 6th.

26,967. "Improvements in automatic pressure regulators for electric collectors." C. de Kando. December 6th. (Complete.)

PUBLISHED SPECIFICATIONS, 1901.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, price, post free, 9d. (in stamps).

3,030. "Improved method of and means for holding and securing the wires of telephone receivers and the like." G. F. Bell and M. Byng. Dated February 12th, 1901.

3,036. "Improvements in or in connection with trolley or like current collectors for electric traction." B. A. Boston. Dated February 12th, 1901.

3,047. "Improvements in apparatus for regulating pressure in electric mains connected to storage batteries." J. S. Highfield. Dated February 12th, 1901.

3,061. "Electric generator." J. Stretch. Dated February 12th, 1901.

3,087. "Improvements in electrical starting and regulating switches." A. H. Hickley. Dated February 13th, 1901.

3,112. "Improvements in systems of electrical distribution." B. G. Lamme. Dated February 13th, 1901.

3,113. "Improvements in rotary field magnets for electrical machines." B. G. Lamme. Dated February 13th, 1901.

3,123. "Improved insulated conduit for the conductors of electric tramways." C. P. Seguy. Dated February 13th, 1901.

3,192. "Improvements in electric furnaces." P. Jurie. Dated February 14th, 1901.

3,206. "Equalising appliances for inter-connected polyphase currents." Siemens Bros. & Co. (Communicated.) Dated February 14th, 1901.

3,207. "Improvements in telephone installations having a central microphone battery." Siemens Bros. & Co. (Communicated.) Dated February 14th, 1901.

3,288. "Improvements in or applicable to dynamos and other electro-magnetic machines." F. J. Howitt and Jackson & Co. Dated February 15th, 1901.

3,370. "Improvements in battery electrodes." J. Liddle. (Communicated.) Dated February 16th, 1901.

3,387. "Device for automatically breaking circuit of trolley wires." E. A. Barber and W. C. Ullmann. Dated February 16th, 1901.

3,388. "Improvements in contact makers for electric igniters." W. P. Thompson. (Communicated.) Dated February 16th, 1901.

3,397. "Improvements in commutator brushes." Siemens Bros. & Co., S. W. Dumas and C. R. Palairet. Dated February 16th, 1901.

3,398. "Improvements in or relating to overhead trolley wires for electric traction, overhead cables, telephone, telegraph wires, or the like." A. W. Hancock, J. Leighton and R. Hacking. Dated February 16th, 1901.

3,416. "Improvements relating to the construction of electrodes containing zinc for use in electric batteries and method of producing and employing same." W. Erny. Dated February 16th, 1901.

3,417. "Improvements in galvanic batteries." W. Erny. Dated February 16th, 1 01.

3,481. "Improvements in apparatus for wireless telegraphy." J. A. Fleming and Marconi's Wireless Telegraph Co. Dated February 18th, 1901.

3,487. "Improvements in or connected with the carrying of strikers upon motor railway and tramway vehicles for mechanically operating electric switches." W. Kingsland. Dated February 18th, 1901.

3,491. "Improvements in arc lamps." J. A. Rignon and T. L. Carbone Dated February 18th, 1901.

3,493. "Improvements in the method for obtaining electric currents from the earth. E. Jahr. Dated February 18th, 1901.

3,494. "Improvements in electrical glow lamps." A. Couch. Dated February 18th, 1901.

3,570 "Improvements in telautographs and methods of telegraphic transmission." A. P. Newton. (Communicated.) Dated February 19th, 1901.

3,576. "Improvements in electric switches or couplings." P. H. F. Spies. Dated February 19th, 1901.

3,636. "Improvements in devices for connecting electrical circuits to earth, in case of emergency, chiefly for use with overhead wires." M. E. Hollingsworth. Dated February 20th, 1901.

3,677. "Improvements in or connected with cable junction boxes." F. Coenen. Dated February 20th, 1901.

3,753. "Improvements in connections for electric conductors." J. D. F. Andrews. Dated February 21st, 1901.

3,823. "Improvements in and connected with conduits for electric wires and cables." R. Ames. Dated February 22nd, 1901.

3,884. "Improved means for starting and regulating the speed of electro-motors with rotating fields." P. J. M. Girault. Dated February 22nd, 1901.

3,860. "Improvements in electro-magnets." E. G. Sheppard. Dated February 22nd, 1901.

3,972. "Improvements in machines or mechanism employed in the manufacture of pipes or tubes or for covering telegraph and telephone cables and wires with lead or other metallic substance for electric purposes." E. A. Claremont. Dated February 25th, 1901.

3,992. "Improvements in electrical accumulators." H. W. Cobb. Dated February 25th, 1901.

4,007. "Improvements in telephonic apparatus for central stations. C. D. Abel. Dated February 25th, 1901.

4,033. "Improvements in controlling apparatus for electric lifts." H. J. Haddan. Dated February 25th, 1901.

4,050. "Improvements in electrical switches." L. P. Perkins. Dated February 25th, 1901.

4,088. "A safety device for overhead systems of street electric transmission of power." C. J. B. Le Mesurier. Dated February 26th, 1901.

4,149. "Improvements in electrically-operated railway and tramway switches." J. H. Spangler. Dated February 26th, 1901.

4,215. "Improvements relating to electric switches." (H. H. Lake.) (Telephon-Fabrik Aktiengesellschaft vorm. J. Berliner; Hanover, Prussia, Germany.) Dated February 27th, 1901.

4,290. "Improvements in mica insulation for electric apparatus." British Thomson-Houston Co. (C. F. Peterson, Schenectady, New York, U.S.A.) (Drawings to specification.) Dated February 28th, 1901.

4,330. "Improvements in the connections, or contacts, of incandescent electric lamps for lighting and heating." H. J. Dowsing. Dated February 28th, 1901.

4,366. "Improvements in safety devices for the trolley poles of electric cars." C. R. Bellamy, W. J. Turner and D. R. Hardman. Dated March 1st, 1901.

4,422. "Improvements in electric primary batteries." C. A. Hussey and S. G. Clarke. Dated March 1st, 1901.

4,429. "Improvements in or relating to electric storage batteries, or accumulators." F. M. Chaplet. Dated March 1st, 1901.

4,489. "Improvements in electrolytic cells and in electrodes therefor." A. A. Vogelsang. Dated March 2nd, 1901.

4,494. "Improved process for making electrodes or accumulators." W. P. Thompson. (Akkumulatoren und Electricitäts-Werke Aktiengesellschaft, formerly W. A. Boese & Co.) Dated March 2nd, 1901.

4,501. "Improvements in electric switches." G. W. Coxson. Dated March 2nd, 1901.

4,503. "Improvements in electric accumulator plates." H. J. H. Pickard and J. S. Evans. Dated March 2nd, 1901.